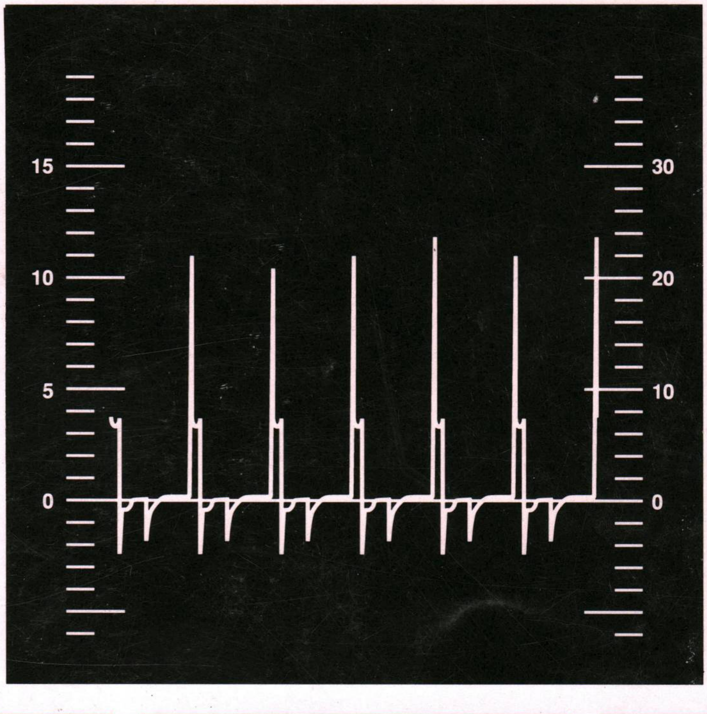
Ignition System Theory and Operation



Ford Customer Service Division
Technical Training

IMPORTANT SAFETY NOTICE

Appropriate service methods and proper repair procedures are essential for the safe, reliable operation of all motor vehicles, as well as the personal safety of the individual doing the work. This manual provides general directions for accomplishing service and repair work with tested, effective techniques. Following them will help assure reliability.

There are numerous variations in procedures, techniques, tools, and parts for servicing vehicles, as well as in the skill of the individual doing the work. This manual cannot possibly anticipate all such variations and provide advice or cautions as to each. Accordingly, anyone who departs from the instructions provided in this manual must first establish that he compromises neither his personal safety nor the vehicle integrity by his choice of methods, tools or parts.

As you read through the procedures, you will come across NOTES, CAUTIONS, AND WARNINGS. Each one is there for a specific purpose. NOTES give you added information that will help you to complete a particular procedure. CAUTIONS are given to prevent you from making an error that could damage the vehicle. WARNINGS remind you to be especially careful in those areas when carelessness can cause personal injury. The following list contains some general warnings that you should follow when you work on a vehicle.

- Always wear safety glasses for eye protection.
- Use safety stands whenever a procedure requires you to be under the vehicle.
- Be sure that the ignition switch is always in the OFF position, unless otherwise required by the procedure.
- Set the parking brake when working on the vehicle. If you have an automatic transmission, set it in PARK unless instructed otherwise for a specific service operation. If you have a manual transmission, it should be in REVERSE (engine OFF) or NEUTRAL (engine ON) unless instructed otherwise for a specific service operation.
- Operate the engine only in a well-ventilated area to avoid the danger of carbon monoxide.
- Keep yourself and your clothing away from moving parts when the engine is running, especially the fan and belts.
- To prevent serious burn, avoid contact with hot metal parts such as the radiator, exhaust manifold, tail pipe, catalytic converter and muffler.
- Do not smoke while working on the vehicle.
- To avoid injury, always remove rings, watches, loose hanging jewelry, and loose clothing before beginning to work on a vehicle. Tie long hair securely behind the head.
- Keep hands and other objects clear of the radiator fan blades. Electric cooling fans can start to operate at any time by an increase in underhood temperatures, even though the ignition is in the OFF position. Therefore, care should be taken to ensure that the electric cooling fan is completely disconnected when working under the hood.

The recommendations and suggestions contained in this manual are made to assist the dealer in improving his dealership parts and/or service department operations. These recommendations and suggestions do not supersede or override the provisions of the Warranty and Policy Manual, and in any cases where there may be a conflict, the provisions of the Warranty and Policy Manual shall govern.

The descriptions, testing procedures and specifications in this handbook were in effect at the time the handbook was approved for printing. Ford Motor Company reserves the right to discontinue models at any time, or change specifications, design or testing procedures without notice and without incurring obligation. Any reference to brand names in this manual is intended merely as an example of the types of tools, lubricants, materials, etc. recommended for use. Equivalents if available may be used. The right is reserved to make changes at any time without notice.

WARNING: Many brake linings contain asbestos fibers. When working on brake components, avoid breathing the dust. Breathing the asbestos dust can cause asbestosis and cancer.

Breathing asbestos dust is harmful to your health.

Dust and dirt present on car wheel brake and clutch assemblies may contain asbestos fibers that are hazardous to your health when made airborne by cleaning with compressed air or by dry brushing.

Wheel brake assemblies and clutch facings should be cleaned using a vacuum cleaner recommended for use with asbestosis fibers. Dust and dirt should be disposed of in a manner that prevents dust exposure, such as sealed bags. The bag must be labeled and the trash hauler notified as to the contents of the bag.

If a vacuum bag suitable for asbestos is not available, cleaning should be done wet. If dust generation is still possible, technicians should wear government approved toxic dust purifying respirators.

OSHA requires areas where asbestos dust generation is possible to be isolated and posted with warning signs. Only technicians concerned with performing brake or clutch service should be present in the area.

Produced and Coordinated by
Technical Training Department
Ford Customer Service Division

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SERVICE STANDARDS

Mission Statement:

All dealership personnel will treat every customer as a potential lifetime purchaser, communicating a professional image which embraces honesty and concern for customer wants and needs.

Dealer-to-Customer Service Standards:

1. Appointment available within one day of the customer's requested service day.
2. Write-up begins within four minutes of arrival.
3. Service needs courteously identified, accurately recorded on Repair Order, and verified with customer.
4. **Vehicles serviced right on the first visit.**
5. Service status provided within one minute of inquiry.
6. Vehicle ready at agreed upon time.
7. Thorough explanation of work done, coverages and charges.

These seven service standards provide a process and product value that are compelling reasons for owners to purchase and repurchase Ford or Lincoln-Mercury products. These standards also help to attract new owners through favorable testimonials and improved owner satisfaction.

Standard 4

"**Fix It Right the First Time, on Time.**"

The technician is the **most important player** when it comes to Standard #4.

Why

Customers tell us "Fixing It Right the First Time, on Time" is one of the top reasons they would decide to return to a dealer to buy a vehicle and get their vehicles serviced.

Technician Training

It is our goal to help the technician acquire all of the skills and knowledge necessary to "Fix It Right the First Time, on Time." We refer to this as "competency."

Technician's Role

To acquire the skills and knowledge for competency in your specialty via

- IVLS (self study)
- CTP (self study)
- New Model (self study and instructor led)
- STST (instructor led)

The Benefits

The successful implementation of standards means

- Satisfied customers
- Repeat vehicle sales
- Repeat service sales
- Recognition that Ford and Lincoln/Mercury technicians are "the Best in the Business"

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INTRODUCTION

MASTERS PROGRAM

The goals of the program are to:

- — increase awareness of available Ford training programs and resources.
- — unify and strengthen existing training and recognition programs.
- — stress the importance of continuous training.
- — recognize technician achievements.

The following chart shows the Specialty Levels and courses in the Masters Program.

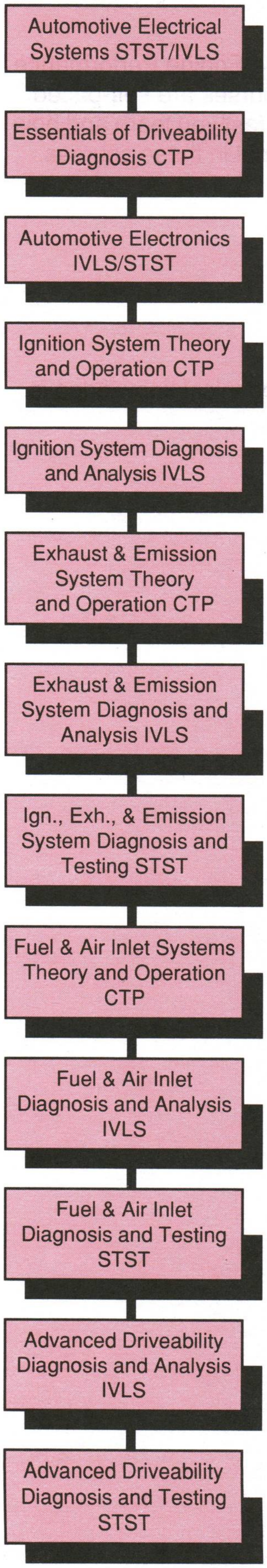
FORD TECHNICAL TRAINING
RECOGNITION PROGRAM

MASTERS

Service Technician Specialty Training Courses

SERVICE SPECIALTY LEVELS	Soft Skills	Elec. Systems	Auto. Elec.	Gas Eng. Ops.	Elec. Eng. Controls	Adv. Elec. Eng. Controls	Diesel Eng. Ops.	Eng. Repair	Susp.	Steer.	NVH	Climate Control	Drive-train Diag.	4X4 Dia. & Repair	Drive-train Repair	Auto Trans. Repair	Auto Trans. Hyd./ Mech. Ops.	NAAO A.T. Elec. Diag.	ASSOC. A.T. Elec. Diag.	Brakes	New Model Training	ASE CERTIFICATION							
																						1	2	3	4	5	6	7	8
Level 1-Ford Technician 1 Year (34)	X	X																											
Level 2-Ford Specialist 2 Years																													
• Engine Performance (31)	X	X	X	X	X	X															X								
• Engine Repair (32)	X	X		X			X	X													X								
• Susp. & Steering (33)	X	X							X	X	X										X								
• Elec. Systems (34)	X	X	X																		X								
• Climate Control (35)	X	X										X									X								
• Man. Trans. & Drivetrain (36)	X										X		X	X	X						X								
• Auto. Trans. (37)	X	X														X	X	X	X		X								
• Brakes (38)	X	X																		X	X								
Level 3-Ford Master Tech 5 Years																													
• Engine	X	X	X	X	X	X	X	X													X	X					X		X
• Transmission	X	X	X		X						X		X	X	X	X	X	X	X		X		X	X			X		
• Chassis	X	X	X						X	X	X		X	X	X					X	X				X	X	X		
• Electronics	X	X	X		X	X			X	X		X						X	X	X	X		X		X	X	X	X	X

INTRODUCTION


Automotive Electrical Systems STST/IVLS
Essentials of Driveability Diagnosis CTP
Automotive Electronics IVLS/STST
Ignition System Theory and Operation CTP
Ignition System Diagnosis and Analysis IVLS
Exhaust & Emission System Theory and Operation CTP
Exhaust & Emission System Diagnosis and Analysis IVLS
Ign., Exh., & Emission System Diagnosis and Testing STST
Fuel & Air Inlet Systems Theory and Operation CTP
Fuel & Air Inlet Diagnosis and Analysis IVLS
Fuel & Air Inlet Diagnosis and Testing STST
Advanced Driveability Diagnosis and Analysis IVLS
Advanced Driveability Diagnosis and Testing STST

ENGINE PERFORMANCE CURRICULUM

Planned Training Pathway

Ford Motor Company has identified the skills and knowledge necessary to meet the curriculum goals. The Planned Training Pathway is a sequence of courses that are designed to provide you with these skills and knowledge. The chart to the left illustrates the courses of this **curriculum**.

Description

The Engine Performance Curriculum consists of thirteen courses. The CTP (Comprehensive Training Program) and IVLS (Interactive Video Learning System) are self-paced and self-study training programs. The STST (Service Technician Specialty Training) courses are hands-on programs that are facilitated by an instructor. The information in the CTP and IVLS courses are designed to prepare you to successfully complete the STST courses. You are currently in the Ignition System Theory and Operation course.

Engine Performance Curriculum Goals

— Provide Necessary Training to Enable Technicians to "Fix it right the first time."

— Increase Technician Productivity

— Increase Customer Satisfaction

— Promote QC-P Improvements

— Lower Customer Complaint Volume

— Lower Repeat Repairs

How to Complete the Curriculum

To successfully complete the Engine Performance Curriculum, you must:

- start at the correct place in the curriculum.
- be fully prepared for each course.
- be willing to learn.

START IN THE CORRECT PLACE

An assessment tool has been developed for technicians entering the Engine Performance Curriculum. This assessment is designed to match your experience and skill with the correct course. For example, if you have previous electrical or engine performance related training and work experience, you may be able to skip the first four courses in the curriculum. If you are just entering the Engine Performance Specialty, you should start at the beginning of the curriculum. See your Service Manager for more details.

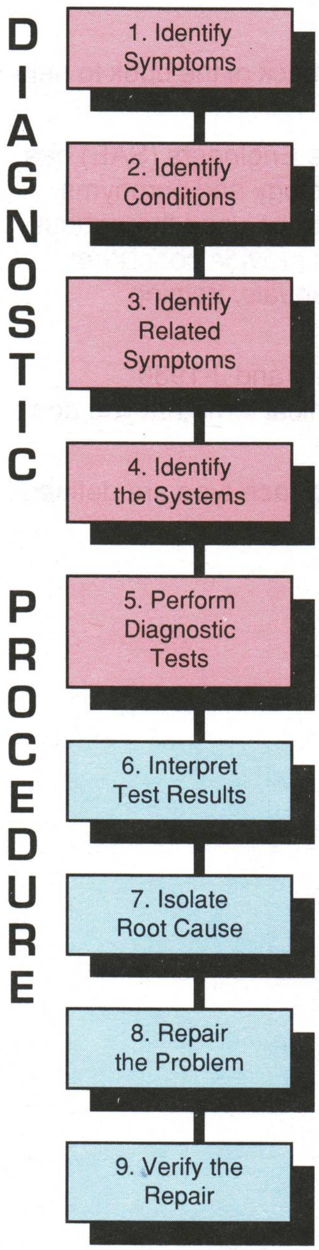
PREPARE FOR EACH COURSE

We recommend that you schedule your training so that when you attend an STST course, the knowledge that you need to know will be fresh in your mind. Each CTP and IVLS course leads up to a STST course. Therefore, you should try to complete the prerequisite CTP and IVLS courses within one month prior to attending the STST course.

WANT TO LEARN

The amount of effort you put into your training will directly affect your success. The Engine Performance Curriculum has several CTP and IVLS courses. Since all of the CTP and IVLS courses are self-paced and self-study programs, you have greater control over how much you learn, how fast you learn and how well you learn it. But it also means that you are responsible for learning the material in these courses. You owe it to yourself to put forth a reasonable effort by:

- setting aside some serious study time.
- following course directions and recommendations.
- scheduling appropriate STST courses.
- completing all requirements prior to attending the STST courses.
- reviewing materials prior to attending any STST course to make sure that all technical knowledge is "fresh."
- attending and participating in all STST course activities.



IGNITION SYSTEM THEORY AND OPERATION

This course provides information on the operation of ignition systems used on Ford, Lincoln and Mercury vehicles. It also incorporates ignition system diagnosis and testing with the diagnostic procedure introduced in course one, "Essentials of Driveability Diagnosis."

Diagnostic Procedure

The shaded steps of the Diagnostic Procedure represent the area of instruction provided by this course. The first three steps of the diagnostic procedure deal with the thought process you use when you diagnose a customer's driveability concern. The fourth step is arrived at by analyzing the results of the previous steps. Step five is used to isolate systems, subsystems and components.

Course Goals

Using the information provided in this course you will demonstrate the following with 100% accuracy:

- identify and describe ignition system related driveability symptoms and conditions.
- identify relationships between symptoms, conditions and the ignition system.
- identify and describe the operation of ignition system components and explain their functions within the system.
- identify and describe ignition system diagnostic procedures and test equipment.

Course Lessons

The lessons of this course are designed to meet the above objectives. It is important that you realize the context in which each lesson presents information.

Lessons 1 through 5 cover those aspects of ignition system operation, diagnosis and testing that are common to all ignition systems. The information presented in these lessons is not specific to any type of ignition system.

Lessons 6 through 8 contain operational and diagnostic information about the ignition systems used on North American Automotive Operation (NAAO) vehicles.

Lesson 9 covers Electronic Engine Control EEC IV and EEC V system diagnosis, as it pertains to ignition systems used on NAAO vehicles.

Lessons 10 through 12 cover the operation, diagnosis and testing of the ignition and EEC systems used in association vehicles.

Testing procedures and test equipment is introduced in this course. However, the material that is presented in this course may not provide specific instructions for performing tests or using the equipment. This material is not a substitute for following the procedures that are outlined in the PCED, or other service manuals. The material presented here is designed to introduce you to the equipment and tests used when performing actual diagnostic services. The IVLS and STST courses in this curriculum will provide further instructions on using test equipment and performing diagnostic tests. Additionally, many references are made to procedures outlined in the PCED manual. It is beneficial to refer to the PCED manual while studying this material.

Progress Check and Post Test Questions

Each lesson of this course has Progress Checks. These are designed to give you quick "feedback" on how well you understand the material. If you miss any Progress Check questions, you should review the material in the lesson.

Post Test questions can be found at the end of this course. The Post Test is designed to let you know if you are ready for the next course. Most CTP courses are followed by an IVLS course. If you have difficulty in the IVLS courses, you will be directed to review the appropriate CTP courses. Therefore, please study all CTP courses carefully.

For those of you who may wish to become ASE (Automotive Service Excellence) certified, we have included some questions in the ASE format. This will help you to score better on ASE tests.

Glossaries

There is a glossary at the back of the book to help you with terminology.

The Society of Automotive Engineers (SAE) has developed a list of terminology and acronyms, called J-1930. This list is to be used throughout the automotive industry to provide consistent descriptions in service manuals, training materials, and parts books.

Please refer to the glossary and J-1930 whenever you see a technical term that you don't understand.

Words that appear in **bold face** type are defined in the glossary.

IGNITION SYSTEM THEORY AND OPERATION

Lesson 1 Spark and Ignition

Lesson 2 Basic Ignition

Lesson 3 Ignition Requirements and Operating Modes

Lesson 4 Ignition Related Driveability Symptoms

Lesson 5 Basic Testing

NAAO

Lesson 6 DI Ignition System

Lesson 7 EI – Low Data Rate Ignition System

Lesson 8 EI – High Data Rate Ignition System

Lesson 9 EEC System Diagnosis

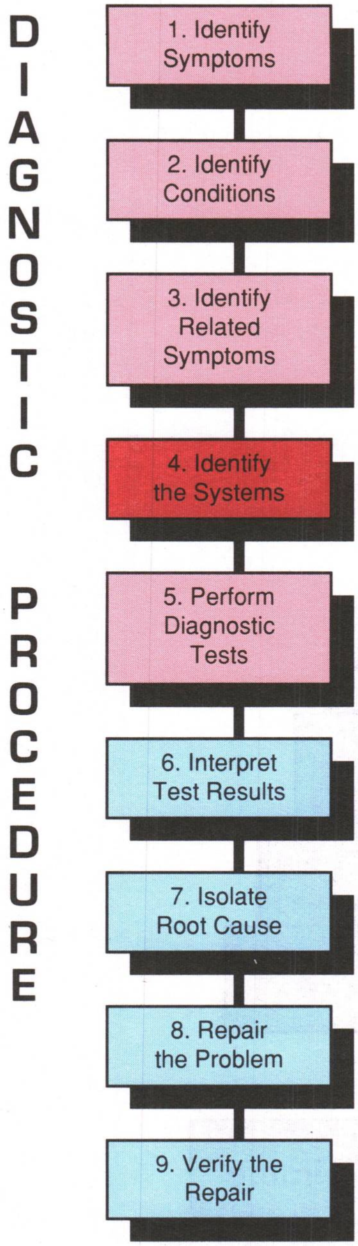
ASSOCIATION

Lesson 10 DI Electronically Controlled Timing

Lesson 11 DI Mechanically Controlled Timing

Lesson 12 Villager DI Ignition System

SPARK AND IGNITION



LESSON 1: SPARK AND IGNITION

Where does this lesson fit into the diagnostic procedure?

The information in this lesson relates to step 4 of the diagnostic procedure. It introduces spark conditions which must be met in order to have proper combustion. To properly analyze ignition system operation you will need to have an understanding of the qualities of ignition spark.

The purpose of all ignition systems is to create a quality spark in the combustion chamber at the correct time to ignite the air/fuel mixture. Proper ignition of the air/fuel mixture is critical to engine performance, fuel economy and emissions. Improper ignition will cause driveability symptoms and create excessive emissions.

Objective(s):

The information provided in this lesson will enable you to identify the driveability symptoms commonly associated with the ignition system.

SPARK AND IGNITION

SPARK QUALITY

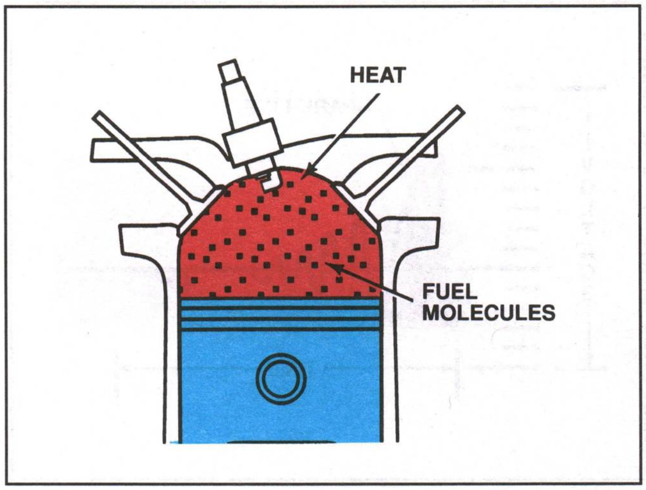


Figure 1-1 — Spark quality

An ignition spark must have two qualities:

- Heat to ignite fuel molecules.
- Duration to last long enough so that the combustion process is started properly.

HEAT

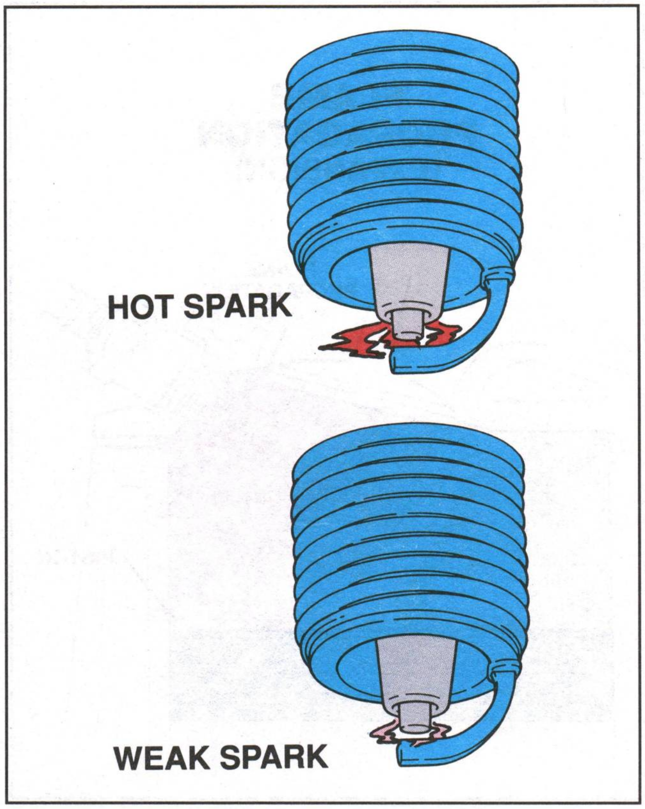


Figure 1-2 — Spark intensity

Heat is generated when **electrons** move across an air gap. By increasing the number of electrons flowing across an air gap, the amount of heat produced by a spark increases. The term hot spark means that there is a good flow of electrons across an air gap.

By decreasing the number of electrons flowing across an air gap, the heat produced by a spark decreases. Minimal electron flow across the spark plug's air gap is called a weak spark.

HEAT AND IGNITION

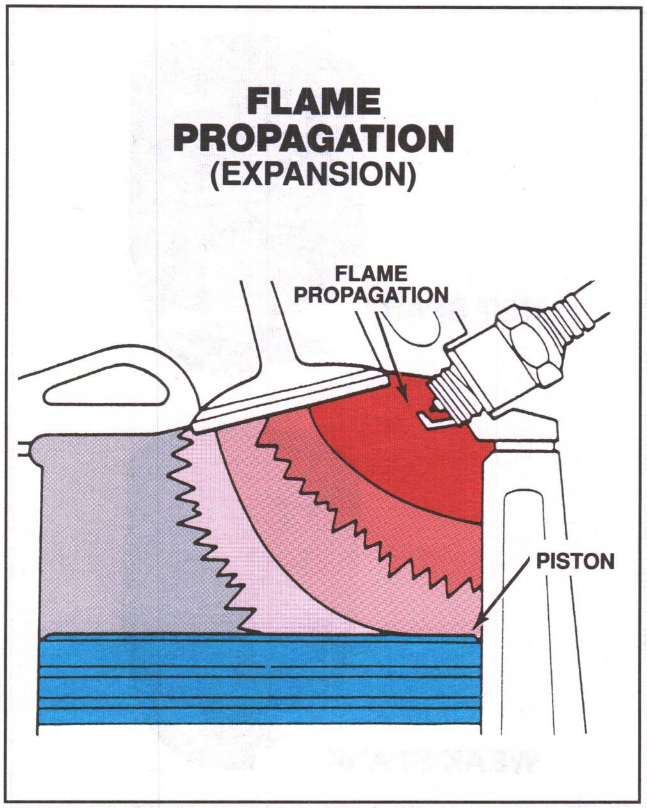


Figure 1-3 — Flame propagation

To ignite an air/fuel mixture, the spark must get some fuel molecules hot enough to burn. When these fuel molecules burn, they give off enough heat to ignite other fuel molecules. Under ideal conditions, this process will continue until all the fuel molecules in the **combustion chamber** are burned.

A weak spark will not produce enough heat to ignite air/fuel molecules reliably. The spark may only ignite an air/fuel mixture some of the time or not at all, depending on how weak the spark is.

SPARK DURATION

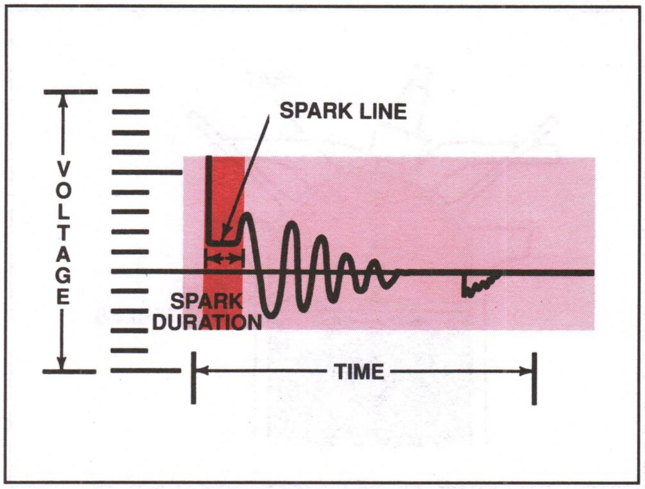


Figure 1-4 — Oscilloscope representation of spark duration

NOTE: The oscilloscope on an engine analyzer can be used to display ignition system electrical current. The above illustration is an oscilloscope pattern that represents spark duration. More information related to engine analyzers will be presented in later lessons.

The length of time a spark is maintained in a combustion chamber is called spark duration. It is measured in **milliseconds (ms)**. Typically, spark duration should be between .8 and 1.5 ms.

Adequate spark duration is essential to ensure proper ignition of the air/fuel mixture. This will allow proper flame propagation (expansion).

SPARK DURATION AND IGNITION

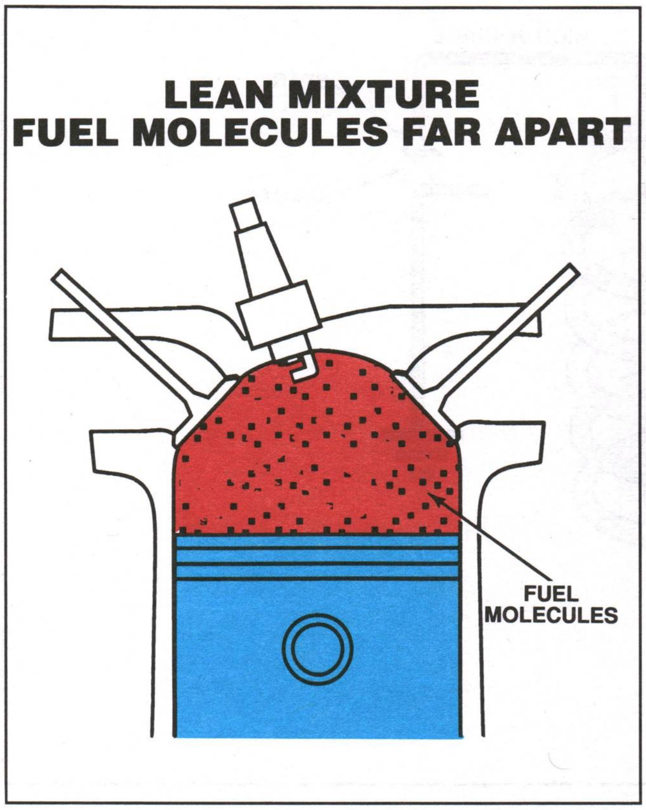


Figure 1-5 — Lean condition

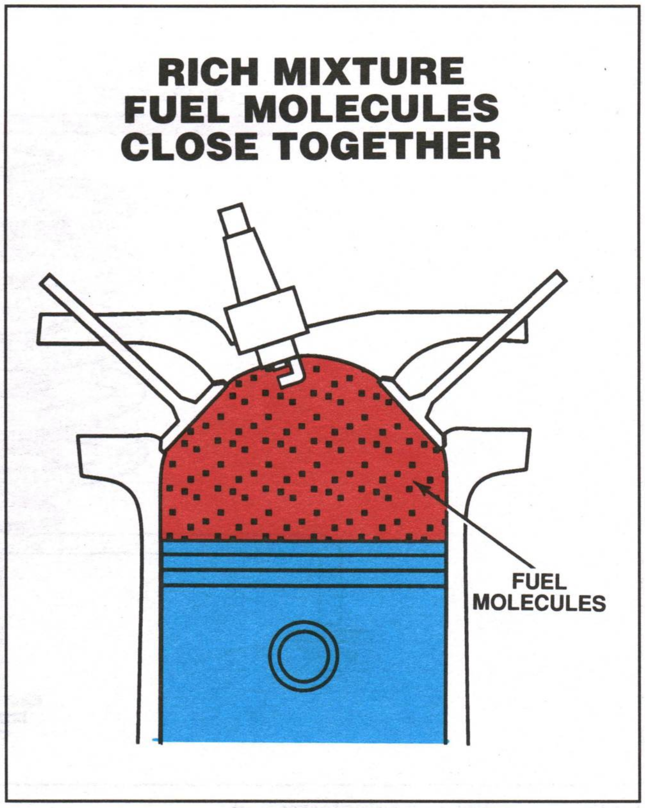


Figure 1-6 — Rich condition

Lean mixtures are difficult to ignite because the fuel molecules are far apart. However, the air/fuel mixture in the combustion chamber is continually moving. As a result, a long spark duration is able to ignite enough fuel molecules to start the combustion process.

Rich mixtures are easier to ignite because the fuel molecules are closer together.

VOLTAGE AND IGNITION

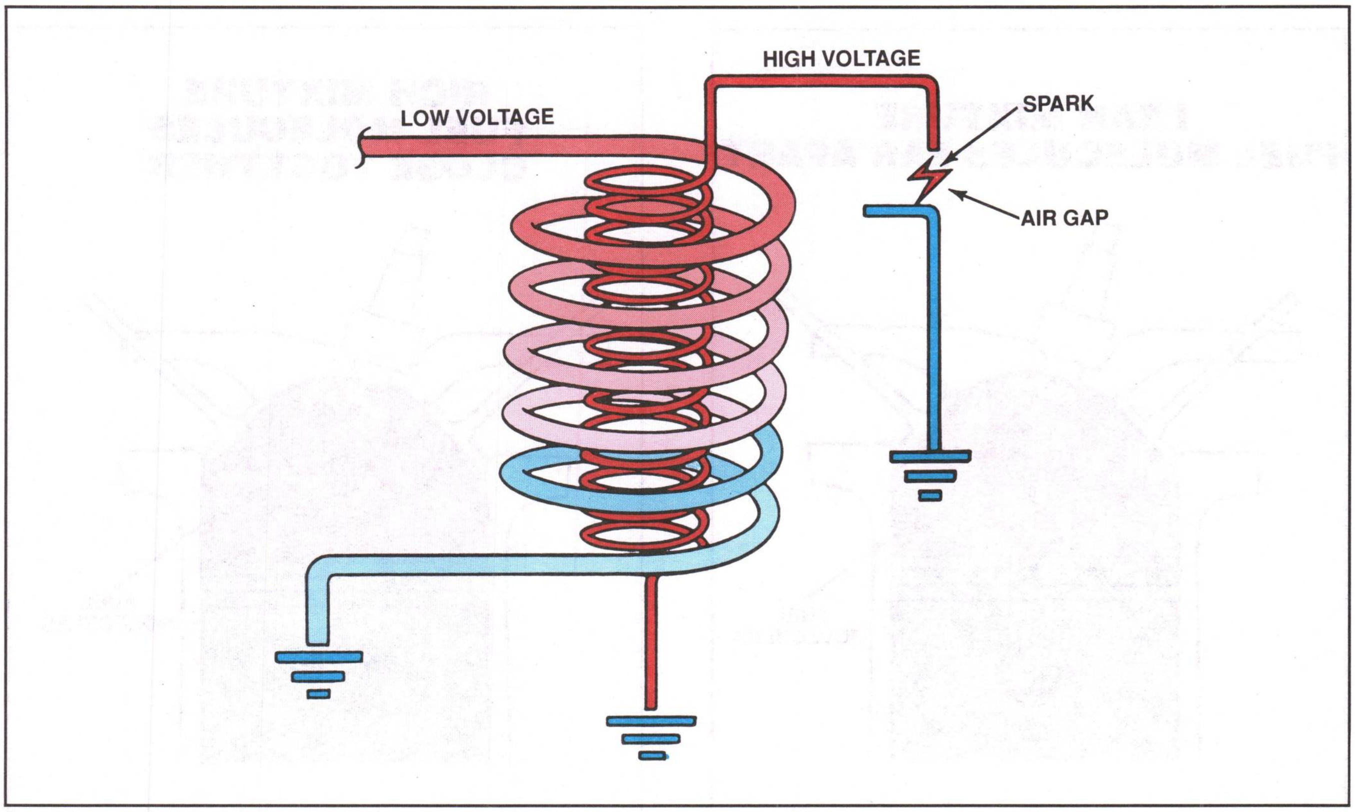


Figure 1-7 — Voltage transformation

To produce a hot spark with proper duration, a high **voltage** electric charge is required to arc the spark plug gap. Several thousand volts are needed to produce a quality spark.

Most automobile electrical systems operate with 12-14 **volts**. The ignition system is responsible for transforming low battery/charging system voltage into the required high voltage. We will discuss how ignition systems accomplish this in the "Basic Ignition" lesson of this course.

This is the end of Lesson 1. Please view Lesson 1 on the video tape, and answer the Progress Check questions.

SPARK AND IGNITION

LESSON 1 – PROGRESS CHECK QUESTIONS

The following questions are based on the information contained in Lesson 1. Choose the **ONE** best correct answer. The answers are provided on the following page. Review any questions missed before proceeding to the next lesson.

1. What are two qualities that an ignition spark must possess?

   A. Heat and Light

   B. Heat and Energy

   C. Heat and Voltage

   D. Heat and Duration

2. Technician A says that a hot spark means that there is good electron flow across the air gap of the spark plug. Technician B says that a weak spark is capable of igniting a lean air/fuel mixture. Who is correct?

   A. Technician A

   B. Technician B

   C. Both A and B

   D. Neither A nor B

3. The length of time that a spark exists across the gap of the spark plug is called:

   A. detonation

   B. duration

   C. timing

   D. dwell

4. Technician A says spark duration is measured in milliseconds. Technician B says that an oscilloscope can be used to analyze spark duration. Who is correct?

   A. Technician A

   B. Technician B

   C. Both A and B

   D. Neither A nor B

SPARK AND IGNITION

LESSON 1 – PROGRESS CHECK ANSWERS

1. What are two qualities that an ignition spark must possess?

   A. Heat and Light

   B. Heat and Energy

   C. Heat and Voltage

   [✓ D.] Heat and Duration

   Heat is needed to ignite nearby fuel molecules. Duration is needed to maintain the spark long enough to spread the heat.

2. Technician A says that a hot spark means that there is good electron flow across the air gap of the spark plug. Technician B says that a weak spark is capable of igniting a lean air/fuel mixture. Who is correct?

   [✓ A.] Technician A

   B. Technician B

   C. Both A and B

   D. Neither A nor B

   A hot spark is caused by good electron flow. A weak spark has poor electron flow and may not provide enough heat for proper combustion.

3. The length of time that a spark exists across the gap of the spark plug is called:

   A. detonation

   [✓ B.] duration

   C. timing

   D. dwell

   Duration means a period of time.

4. Technician A says spark duration is measured in milliseconds. Technician B says that an oscilloscope can be used to analyze spark duration. Who is correct?

   A. Technician A

   B. Technician B

   [✓ C.] Both A and B

   D. Neither A nor B

   Spark duration is measured in milliseconds (ms), and an engine analyzer's oscilloscope can be used to analyze spark duration.

LESSON 1 – PROGRESS CHECK QUESTIONS (CONT'D.)

5. Technician A says the ignition system needs to produce a hot spark in order to properly ignite the air/fuel mixture. Technician B says that several thousand volts are required to produce a quality spark. Who is correct?

   A. Technician A

   B. Technician B

   C. Both A and B

   D. Neither A nor B

LESSON 1 – PROGRESS CHECK ANSWERS (CONT'D.)

5. Technician A says the ignition system needs to produce a hot spark in order to properly ignite the air/fuel mixture. Technician B says that several thousand volts are required to produce a quality spark. Who is correct?

   A. Technician A
   B. Technician B
   [✓ C.] Both A and B
   D. Neither A nor B

   In order to properly ignite the air/fuel mixture a hot spark is required. Several thousand volts are required to produce a good hot spark.

IGNITION SYSTEM THEORY AND OPERATION

Lesson 1 Spark and Ignition

Lesson 2 Basic Ignition

Lesson 3 Ignition Requirements and Operating Modes

Lesson 4 Ignition Related Driveability Symptoms

Lesson 5 Basic Testing

NAAO

Lesson 6 DI Ignition System

Lesson 7 EI – Low Data Rate Ignition System

Lesson 8 EI – High Data Rate Ignition System

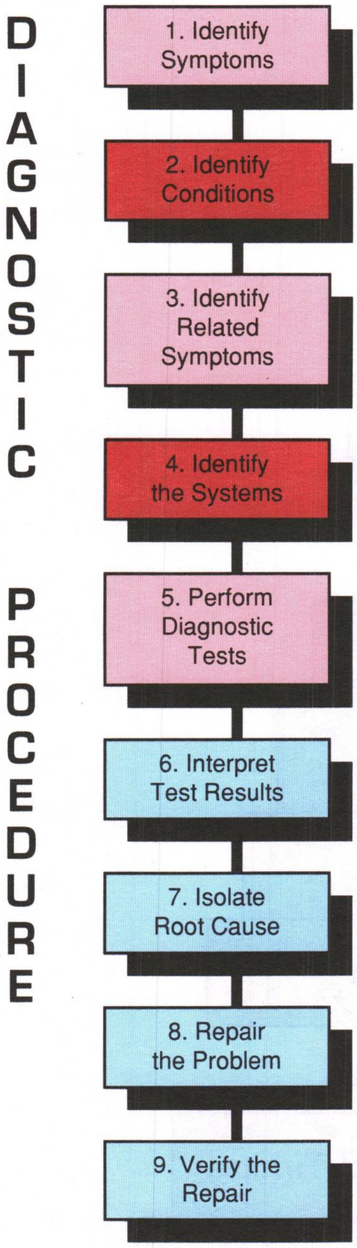
Lesson 9 EEC System Diagnosis

ASSOCIATION

Lesson 10 DI Electronically Controlled Timing

Lesson 11 DI Mechanically Controlled Timing

Lesson 12 Villager DI Ignition System



LESSON 2: BASIC IGNITION

Where does this lesson fit into the diagnostic procedure?

The information in this lesson relates to steps 2 and 4 of the diagnostic procedure. It covers the various conditions that the ignition system must meet in order to produce a spark. In order to evaluate and diagnose ignition spark concerns it is necessary to know the conditions that must exist to create a good spark.

This lesson presents general information on ignition system operation.

There are several types of systems. They all share basic operating characteristics. The different systems used on Ford, Lincoln and Mercury vehicles are covered in later lessons.

Objective(s):

The information provided in this lesson will enable you to identify the driveability symptoms commonly associated with the ignition system.

VOLTAGE AND COILS

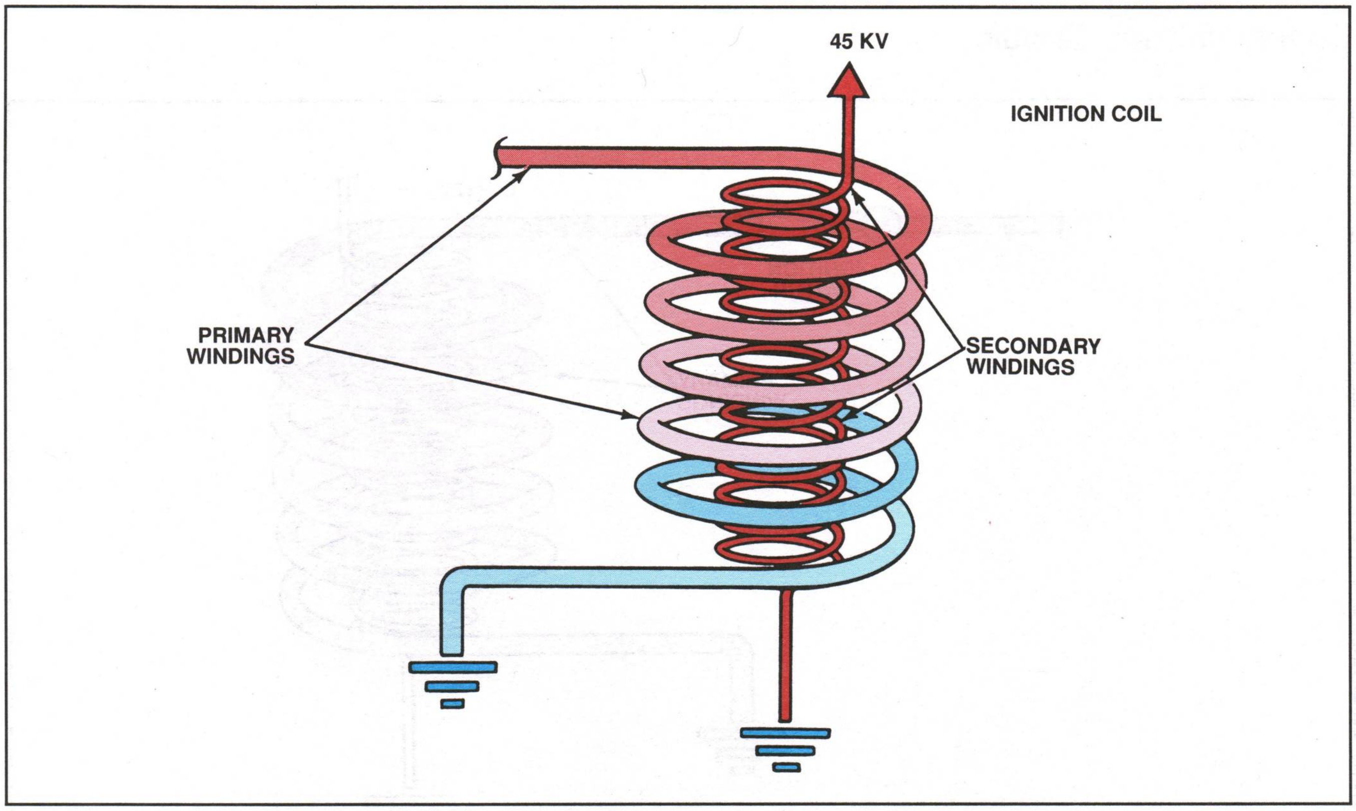


Figure 2-1 — Ignition coil

The **ignition coil** is the component that converts low voltage into the required high voltage. This high voltage is used to create a spark in the combustion chamber. Typically, ignition coils are capable of producing greater than 25 Kv.

All ignition coils have a primary and secondary winding. The secondary winding contains many times more windings of wire than the primary winding.

IGNITION PRIMARY CIRCUIT

Supply Voltage Circuit

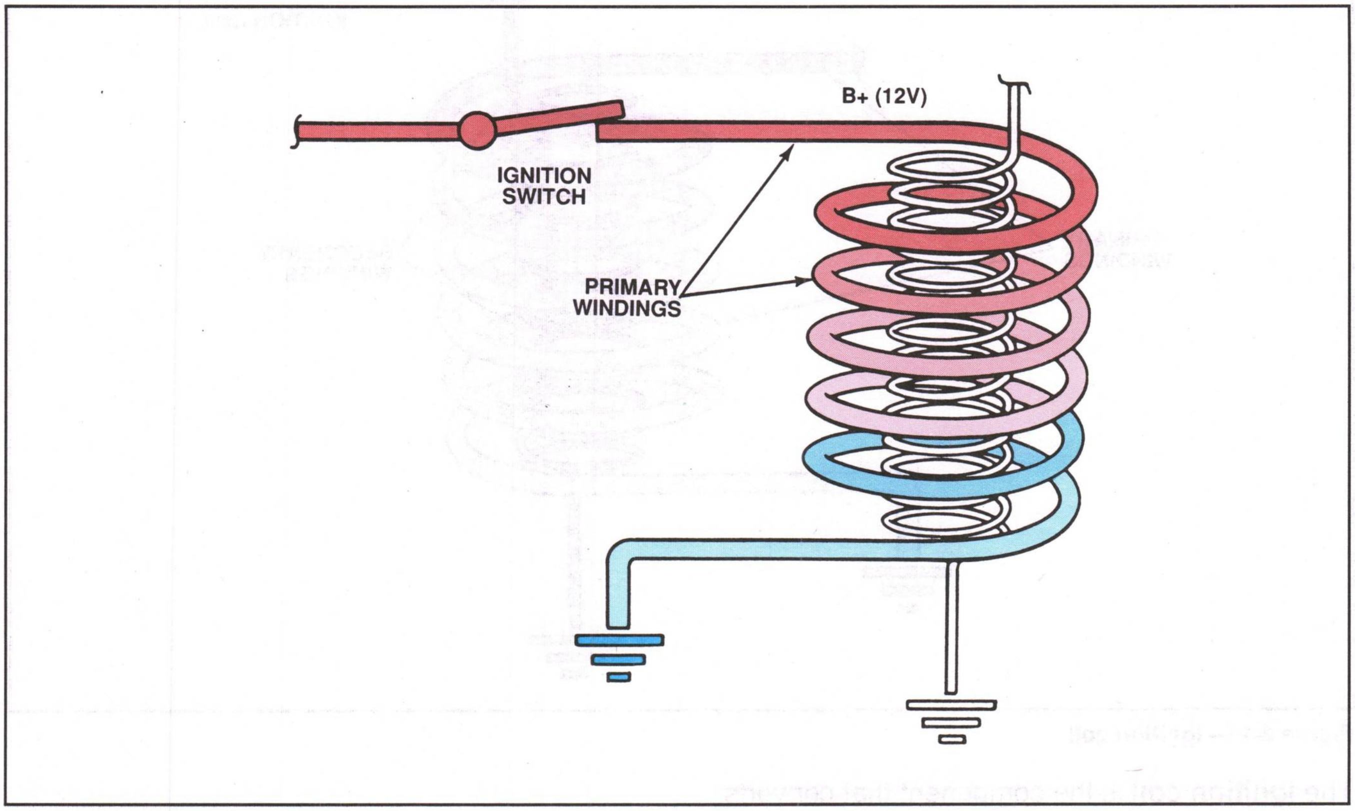


Figure 2-2 — Primary circuit

When the key is ON, battery voltage is supplied to the **ignition switch** and primary winding of the coil.

Ground Circuit

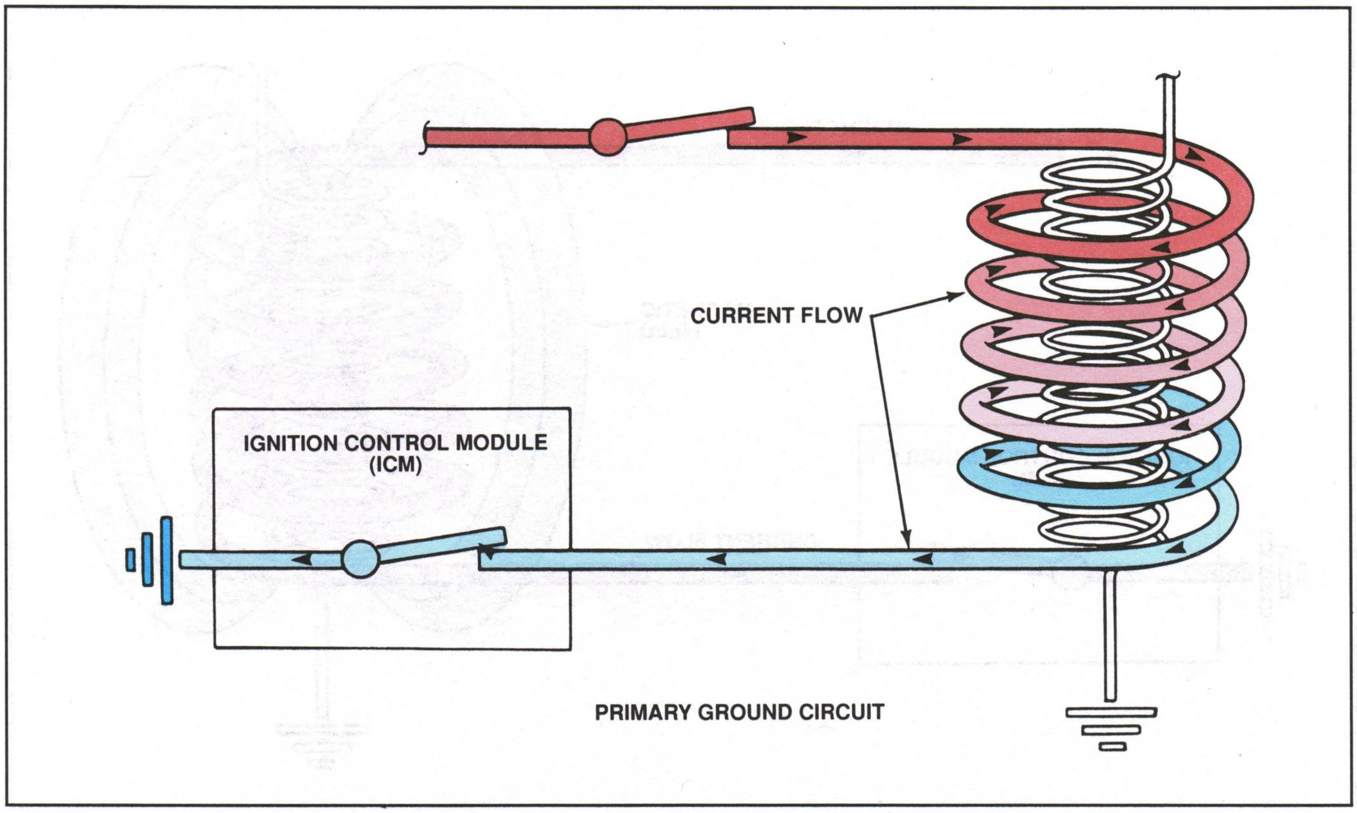


Figure 2-3 — Primary ground circuit

The ground circuit for the primary winding is provided by a **switch** inside the **Ignition Control Module (ICM)**. When the switch is closed, current flows through the ignition supply circuit, the coil primary winding and the ground circuit.

Current Flow and Coil Saturation

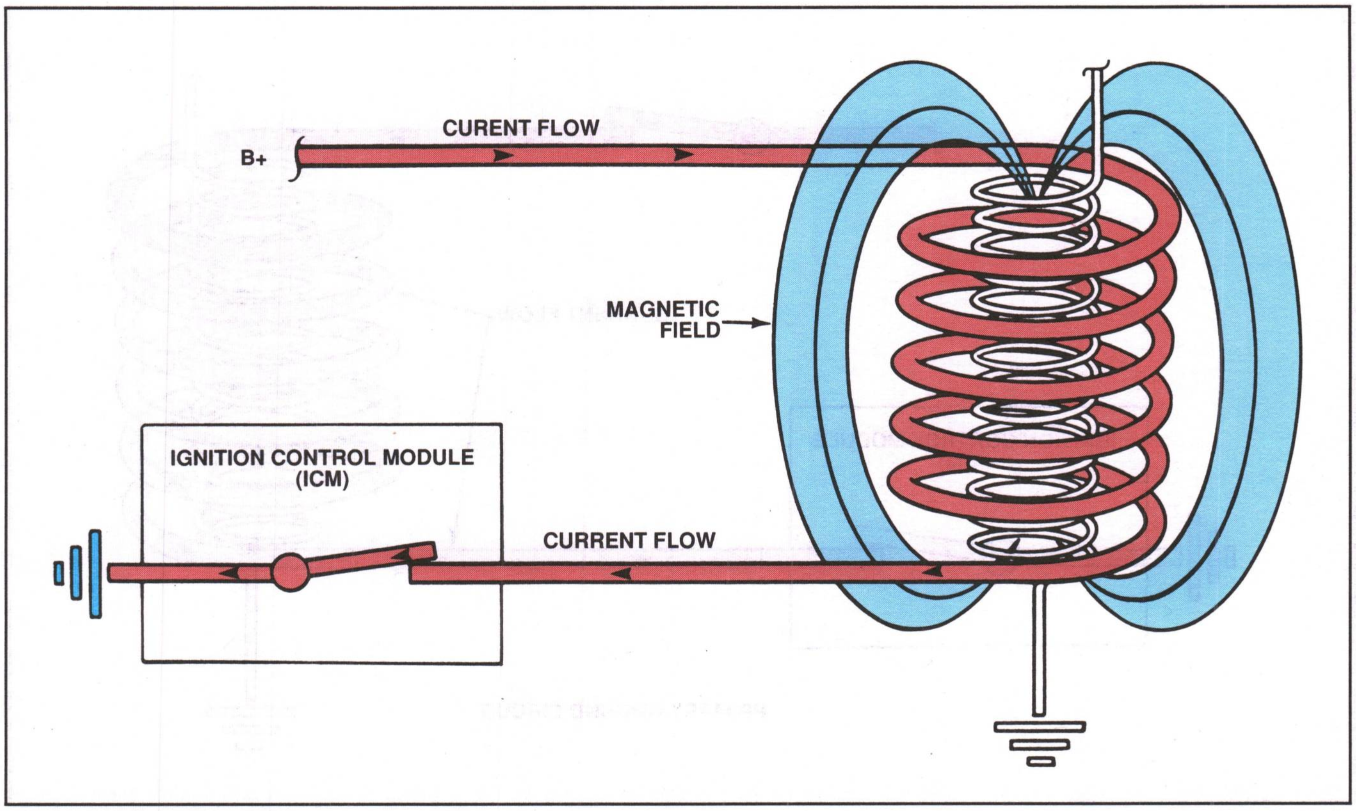


Figure 2-4 — Coil saturation

Current flow through the primary winding creates a **magnetic field** around the coil. The strength of the magnetic field depends on the amount of current flowing through the primary winding. When the maximum primary current flow is obtained, called **coil saturation**, the magnetic field is at maximum strength. It takes approximately 3 ms for most coils to reach full saturation.

Primary Current Flow and Dwell

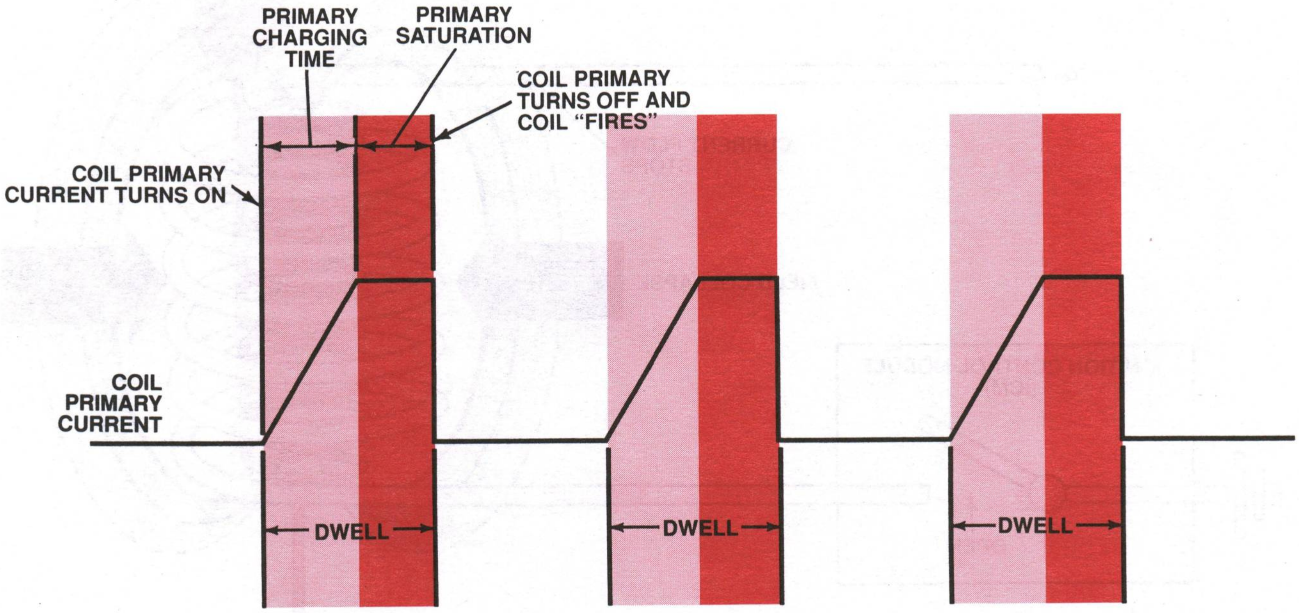


Figure 2-5 — Coil dwell

Dwell is the amount of time that current is flowing through the primary circuit.

Primary Circuit Magnetic Field Collapse

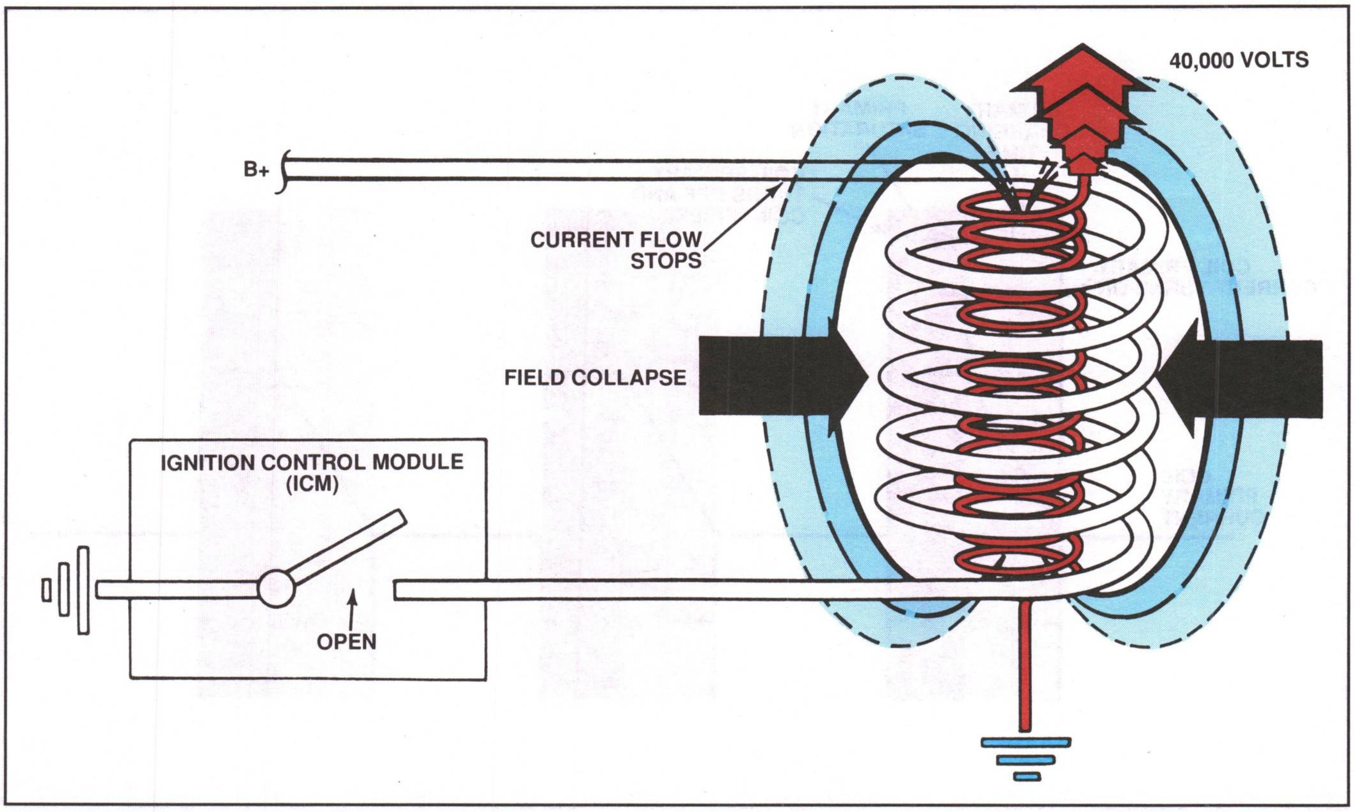


Figure 2-6 — Magnetic field collapse

When the switch inside the ignition module opens, primary current flow stops. This causes the magnetic lines of force around the primary winding to **collapse**. When the field collapses, the lines of **magnetic force** move very quickly to the center and induce higher voltage into the secondary windings.

Secondary Circuit Voltage Induction

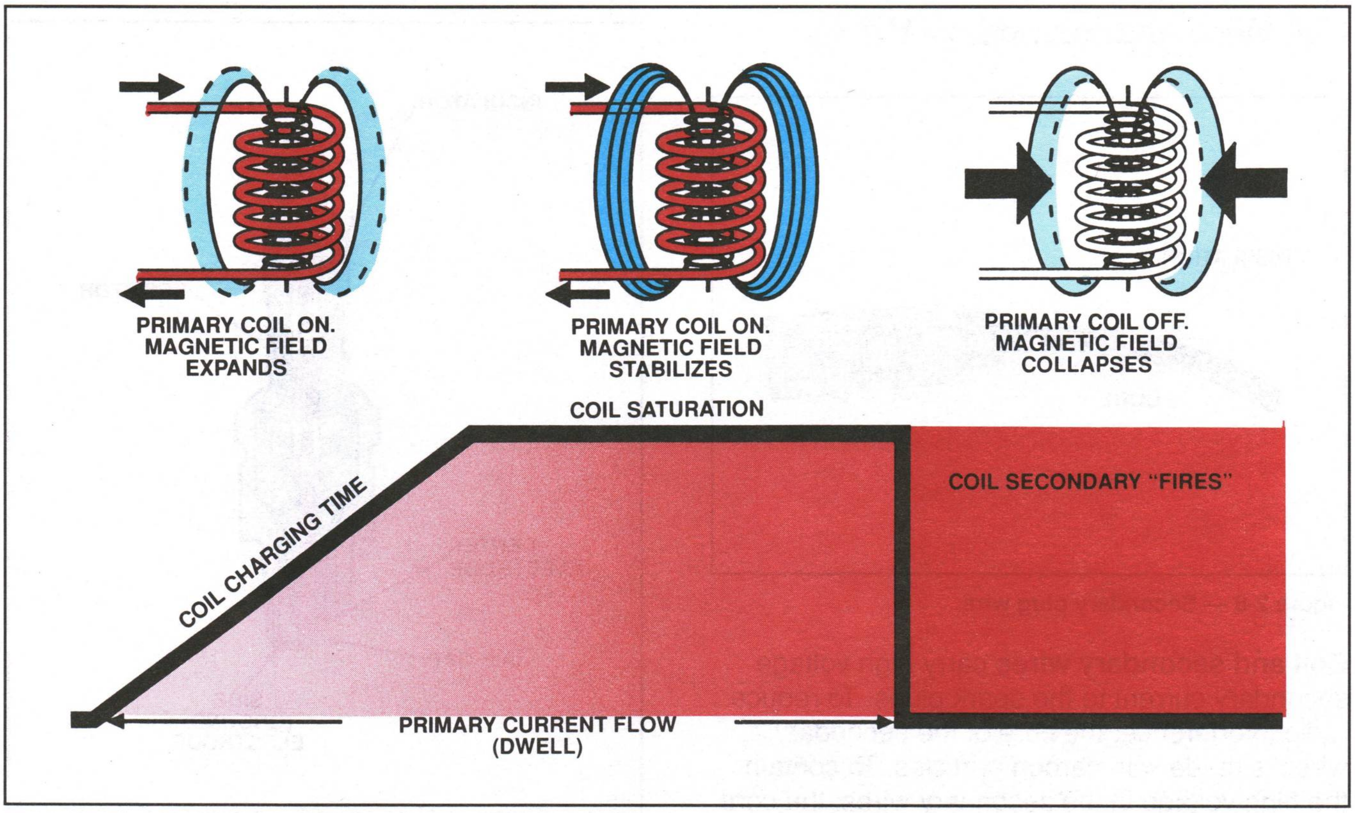


Figure 2-7 — The magnetic induction process

Low voltage current flows through the coil's primary winding when the switch inside the ignition module is closed. A magnetic field is produced and expands.

The coil reaches its saturation point and the magnetic field stabilizes.

The switch inside the ignition module opens, the magnetic field collapses, high voltage is induced into the secondary winding and the coil fires.

COIL SECONDARY CIRCUIT

Coil Wire and Secondary Wires

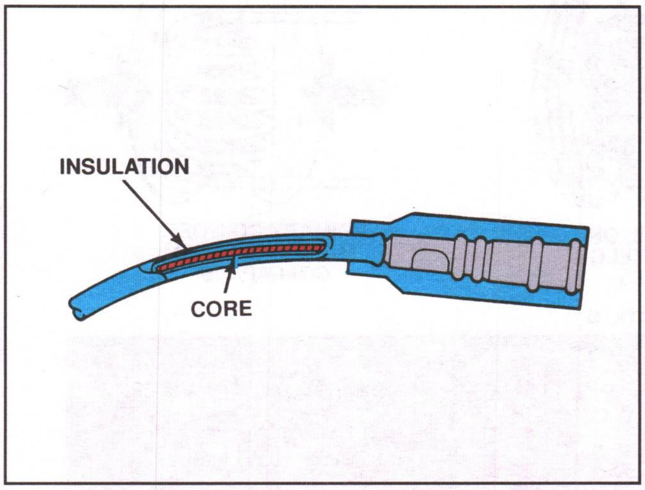


Figure 2-8 — Secondary plug wire

Coil and secondary wires carry high voltage secondary current to the spark plugs. To reduce radio interference, the core of the secondary wires is made with carbon particles. To contain the high voltage in the secondary wires, the core is covered with a thick layer of **insulation**.

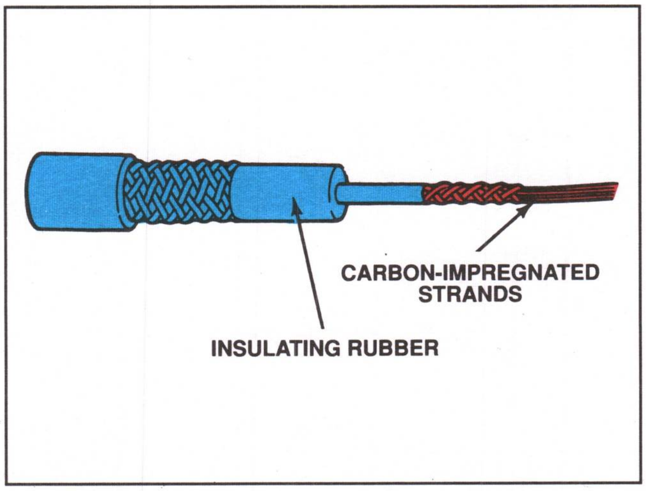


Figure 2-9 — Plug wire construction

Spark Plugs

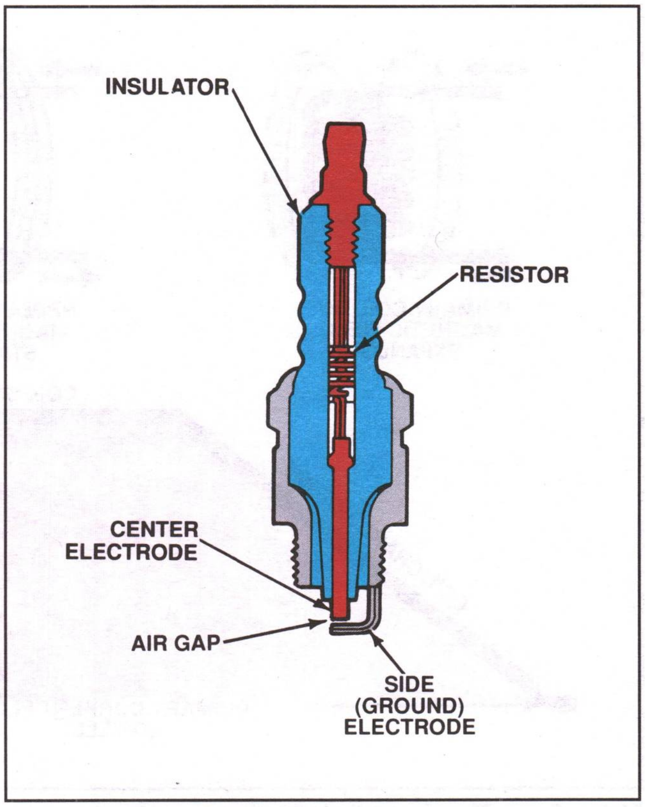


Figure 2-10 — Spark plugs

The **spark plug** is designed to create a quality spark inside the combustion chamber. The spark occurs when voltage arcs across the plug's **electrodes**.

The secondary ignition wire is connected to the center electrode. The current flows through a resistor to reduce radio interference. The voltage causes the electrons to jump across the air gap to ground. The ground path is through the side electrode to the cylinder head. A porcelain insulator separates the power and ground paths of the spark plug.

NOTE: There are different spark plug styles, constructions and heat ranges. Always install the correct plugs in the vehicle. Refer to the Vehicle Emission Control Information (VECI) decal or the appropriate Emissions Facts book for the correct spark plug application.

BASE ENGINE TIMING

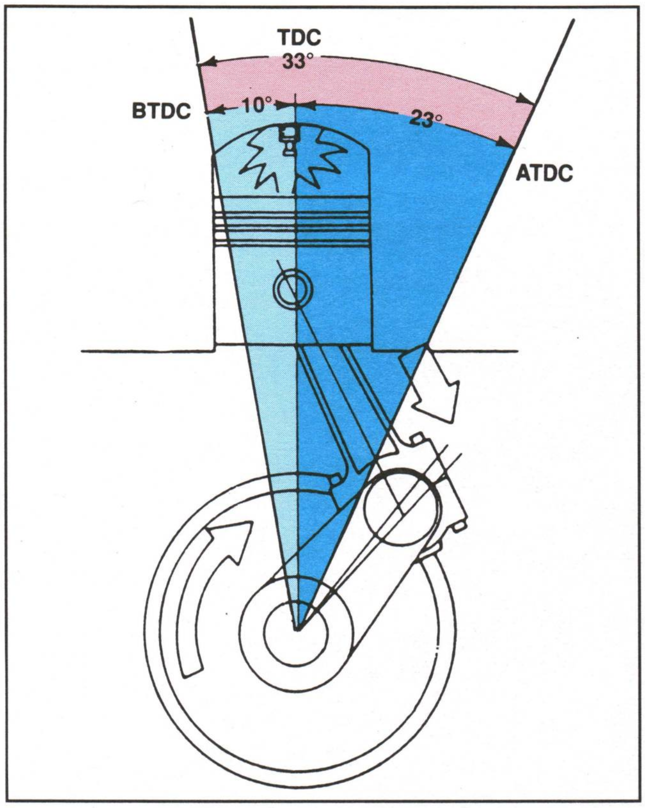


Figure 2-11 — Ignition to combustion chamber

Ignition timing, also called spark timing, refers to how early or late the spark plugs fire in relation to the position of the piston on the compression stroke. For the engine to run efficiently and produce low emissions, the combustion process should be completed approximately 23° **After Top Dead Center (ATDC).**

SPARK ADVANCE AND ENGINE SPEED

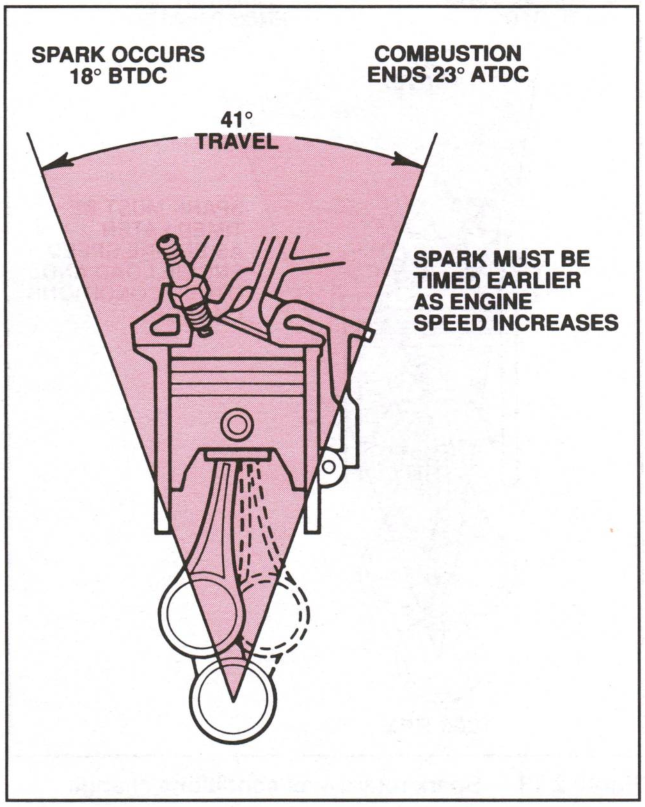


Figure 2-12 — Advancing spark

Because each combustion process takes about the same amount of time to complete, the spark must occur sooner as engine speed increases. When the spark occurs earlier on the compression stroke, timing is “advanced.”

Spark Retard

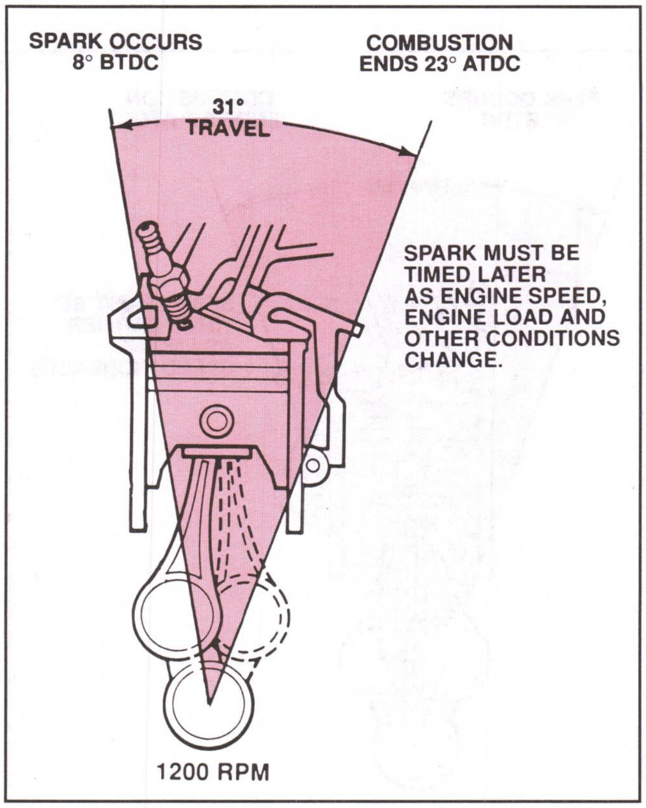


Figure 2-13 — Spark retard – as conditions change

The amount of spark advance typically decreases as engine speed decreases. Decreasing the amount of advance is known as timing retard. When the timing retards, the spark occurs later on the compression stroke.

NOTE: Ignition timing requirements can be affected by other conditions such as engine load, air/fuel mixtures, engine temperature, intake air temperature and intake air density. Specific timing control methods will be discussed in later lessons.

This is the end of Lesson 2. Now view Lesson 2 on the video tape, and answer the Progress Check questions.

LESSON 2 – PROGRESS CHECK QUESTIONS

The following questions are based on the information contained in Lesson 2. Choose the **ONE** best correct answer. The answers are provided on the following page. Review any questions missed before proceeding to the next lesson.

1. The ignition coil contains:
   - A. primary and secondary windings with equal wiring turns.
   - B. more primary windings than secondary windings.
   - C. more secondary windings than primary windings.
   - D. only secondary windings.

2. Technician A says that battery voltage is supplied to the secondary windings of the coil when the ignition switch is ON. Technician B says that battery voltage is supplied to the primary windings of the coil at all times, key ON or OFF. Who is correct?
   - A. Technician A
   - B. Technician B
   - C. Both A and B
   - D. Neither A nor B

3. Primary current flow is grounded when:
   - A. a transistor inside the ICM closes.
   - B. a transistor inside the ICM opens.
   - C. the ignition switch is turned to the ON position.
   - D. the ignition switch is turned to the OFF position.

4. Technician A says that current flow through the coil's secondary windings causes a high voltage to be induced. Technician B says that coil saturation means that the magnetic field produced around the coil's primary windings has reached maximum strength. Who is correct?
   - A. Technician A
   - B. Technician B
   - C. Both A and B
   - D. Neither A nor B

LESSON 2 – PROGRESS CHECK ANSWERS

1. The ignition coil contains:

A. primary and secondary windings with equal wiring turns.
B. more primary windings than secondary windings.
[✓ C.] more secondary windings than primary windings.
D. only secondary windings.

In order to create high voltage, there must be many more secondary windings than primary windings.

2. Technician A says that battery voltage is supplied to the secondary windings of the coil when the ignition switch is ON. Technician B says that battery voltage is supplied to the primary windings of the coil at all times, key ON or OFF. Who is correct?

A. Technician A
B. Technician B
C. Both A and B
[✓ D.] Neither A nor B

Battery voltage is supplied to the primary windings of the coil only when the key is ON.

3. Primary current flow is grounded when:

[✓ A.] a transistor inside the ICM closes.
B. a transistor inside the ICM opens.
C. the ignition switch is turned to the ON position.
D. the ignition switch is turned to the OFF position.

When the circuit is closed, current flow through the primary windings occurs. A circuit is only complete when current flows from a power source to ground.

4. Technician A says that current flow through the coil's secondary windings causes a high voltage to be induced. Technician B says that coil saturation means that the magnetic field produced around the coil's primary windings has reached maximum strength. Who is correct?

A. Technician A
[✓ B.] Technician B
C. Both A and B
D. Neither A nor B

High voltage is not induced because of current flow through the secondary windings. Coil saturation means that full magnetic field strength has been reached.

LESSON 2 – PROGRESS CHECK QUESTIONS (CONT'D.)

5. Technician A says that dwell refers to the amount of time current flows through the primary windings of the coil. Technician B says that it takes approximately 3 ms for a coil to reach full saturation. Who is correct?
   A. Technician A
   B. Technician B
   C. Both A and B
   D. Neither A nor B

6. The magnetic field collapses across the coil's secondary windings when:
   A. the ignition switch is turned off.
   B. the ignition switch is turned on.
   C. the transistor inside the ICM closes.
   D. the transistor inside the ICM opens.

7. Technician A says that timing needs to be advanced when engine speed increases. Technician B says that ignition timing can be affected by engine load. Who is correct?
   A. Technician A
   B. Technician B
   C. Both A and B
   D. Neither A nor B

LESSON 2 – PROGRESS CHECK ANSWERS (CONT'D.)

5. Technician A says that dwell refers to the amount of time current flows through the primary windings of the coil. Technician B says that it takes approximately 3 ms for a coil to reach full saturation. Who is correct?

   A. Technician A

   B. Technician B

   [✓ C.] Both A and B

   D. Neither A nor B

   Dwell is the amount of time current flows through the primary windings of the coil; and typical saturation time is 3 ms.

6. The magnetic field collapses across the coil's secondary windings when:

   A. the ignition switch is turned off.

   B. the ignition switch is turned on.

   C. the transistor inside the ICM closes.

   [✓ D.] the transistor inside the ICM opens.

   When the ICM opens the transistor, primary current flow stops and the magnetic field produced around the coil's primary windings collapses across the coil's secondary windings.

7. Technician A says that timing needs to be advanced when engine speed increases. Technician B says that ignition timing can be affected by engine load. Who is correct?

   A. Technician A

   B. Technician B

   [✓ C.] Both A and B

   D. Neither A nor B

   Ignition timing must occur earlier when engine speed increases so that the combustion process ends at the proper time. Other factors, such as engine load and air/fuel mixtures, affect ignition timing.

IGNITION SYSTEM THEORY AND OPERATION

Lesson 1 Spark and Ignition

Lesson 2 Basic Ignition

Lesson 3 Ignition Requirements and Operating Modes

Lesson 4 Ignition Related Driveability Symptoms

Lesson 5 Basic Testing

NAAO

Lesson 6 DI Ignition System

Lesson 7 EI – Low Data Rate Ignition System

Lesson 8 EI – High Data Rate Ignition System

Lesson 9 EEC System Diagnosis

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Lesson 10 DI Electronically Controlled Timing

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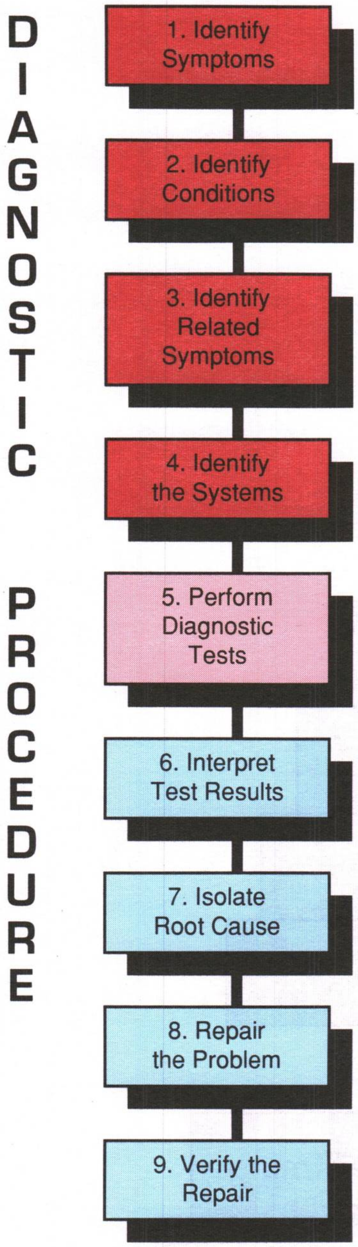
Lesson 12 Villager DI Ignition System



LESSON 3: IGNITION REQUIREMENTS AND OPERATING MODES

Where does this lesson fit into the diagnostic procedure?

The information in this lesson relates to steps 1, 2, 3, and 4 of the diagnostic procedure. It identifies and describes engine operating modes and conditions within which the ignition system must function. Since the engine operates under varying conditions, the ignition system must operate under these conditions too. To properly evaluate and diagnose the ignition system, it is necessary to identify ignition requirements for each engine condition and operating mode.

The engine operating modes affecting the ignition system are as follows:

- Starting
- Idle
- Cruise
- Acceleration

Objective(s):

The information in this lesson will enable you to identify the driveability symptoms commonly associated with the ignition system.

IGNITION REQUIREMENTS AND OPERATING MODES

SECONDARY VOLTAGE AND OPERATING MODES

Compression pressures and air/fuel ratios affect ignition voltage and duration requirements. When the air/fuel mixture is compressed, higher voltage is required to arc the spark plug's gap. This is because there is more air resistance to overcome.

NOTE: There are many more air molecules than fuel molecules in a typical air/fuel mixture. Compressed air molecules add resistance that must be overcome by higher ignition voltage.

Compression pressures and air fuel ratios change with different operating modes. Therefore, it is important to identify the ignition system requirements for each operating mode. This will help you understand what ignition system conditions might be responsible for a driveability concern.

Starting

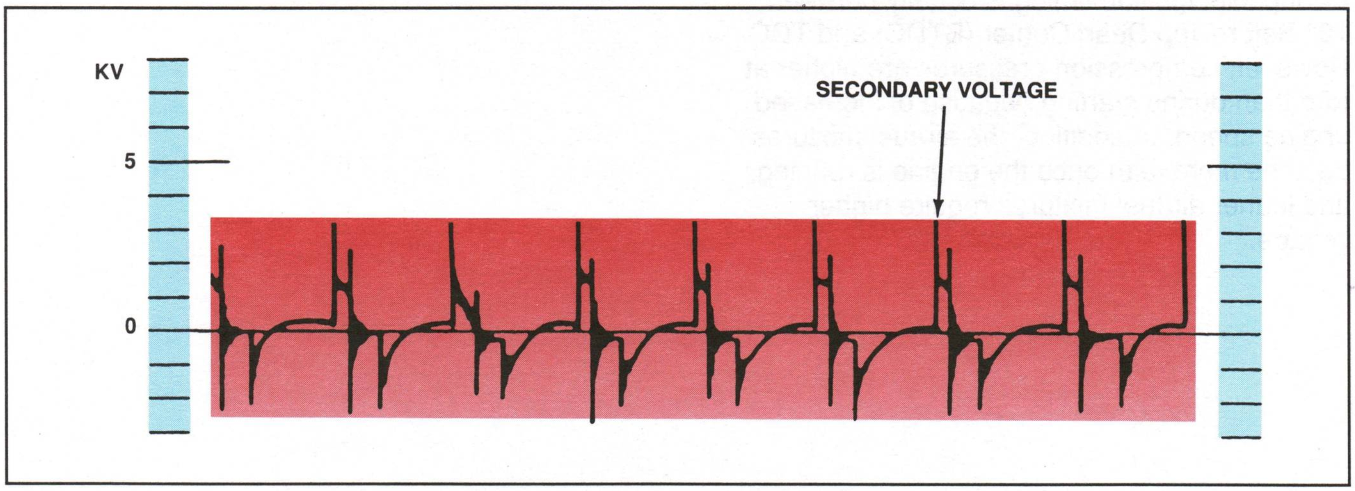


Figure 3-1 — Starting secondary voltage

Engine **cranking** speed for most engines is 200-400 RPM. Slower engine speeds cause lower compression pressures. As a result, the secondary voltage requirements for ignition during **starting** are lower than for other operating modes. In addition, **richer air/fuel mixtures** are used during the starting mode which reduces secondary voltage requirements.

Ignition timing also has an effect on secondary voltage requirements. Compression pressures increase as the piston moves toward Top Dead Center (TDC). As a result, higher secondary voltages are required when the piston is at TDC. During the cranking mode, ignition timing is typically near TDC. Normally this would increase secondary voltage. However, since cranking speed is not capable of producing maximum compression pressures, secondary voltage is usually normal to low depending on the condition of the engine.

Idle

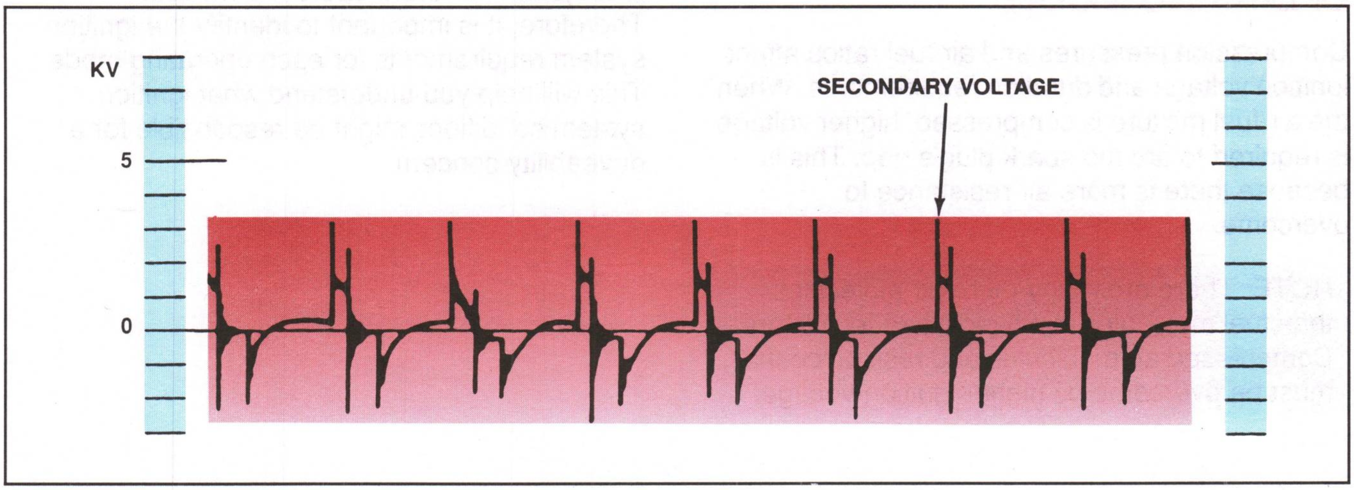


Figure 3-2 — Idle secondary voltage

During idle, ignition timing is usually between 10° Before Top Dead Center (BTDC) and TDC. However, compression pressures are higher at **idle** than during starting because of increased engine speed. In addition, the air/fuel mixtures become more lean once the engine is running, and leaner air/fuel mixtures require higher voltage.

Cruise

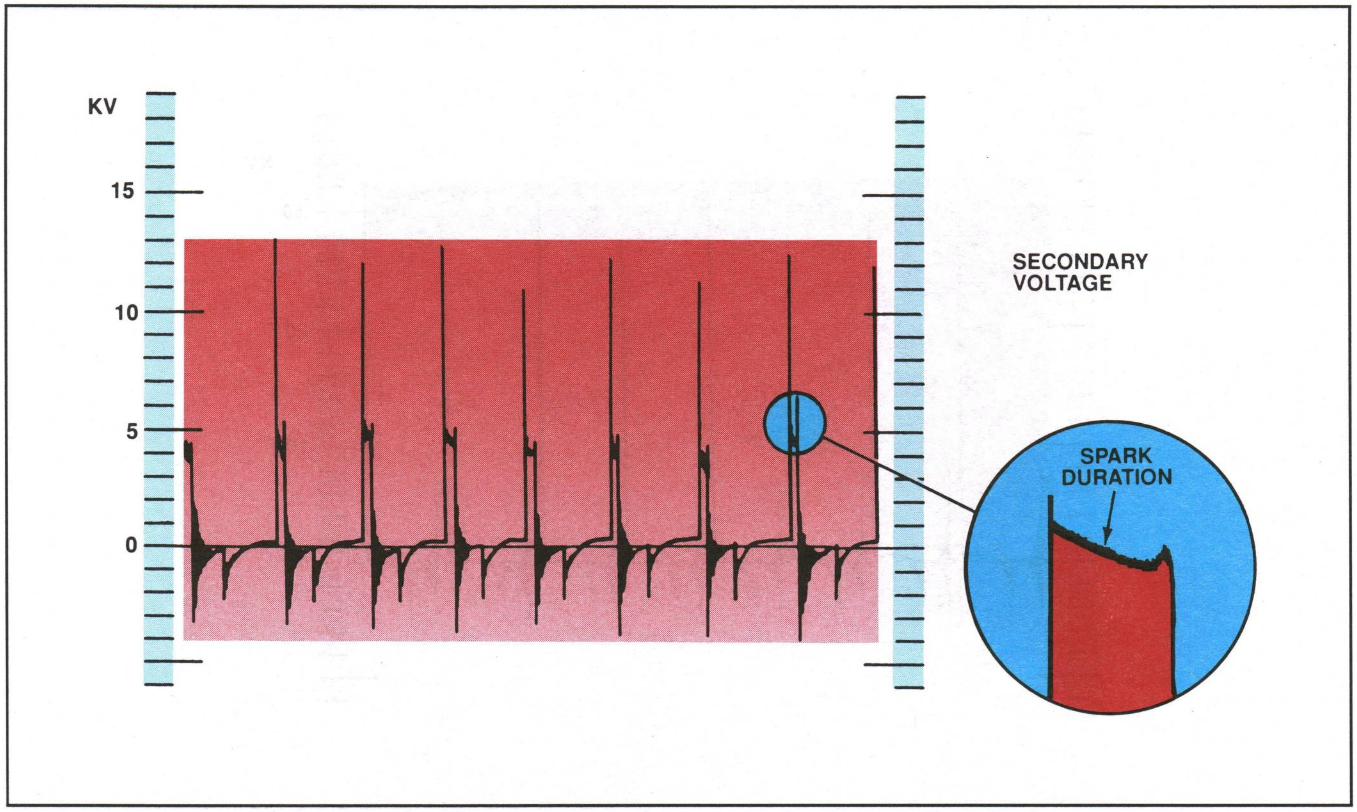


Figure 3-3 — Cruise secondary voltage

Secondary voltage requirements will vary depending on the **cruise** mode of the engine. This is because of the amount of spark advance. Typically, high engine speeds and lean air/fuel mixtures call for several degrees of spark advance.

Spark duration is a critical factor during the cruise mode. Spark duration is critical because air/fuel mixtures are lean and economical during the cruise mode. A long spark duration is needed to reliably ignite this mixture.

Acceleration

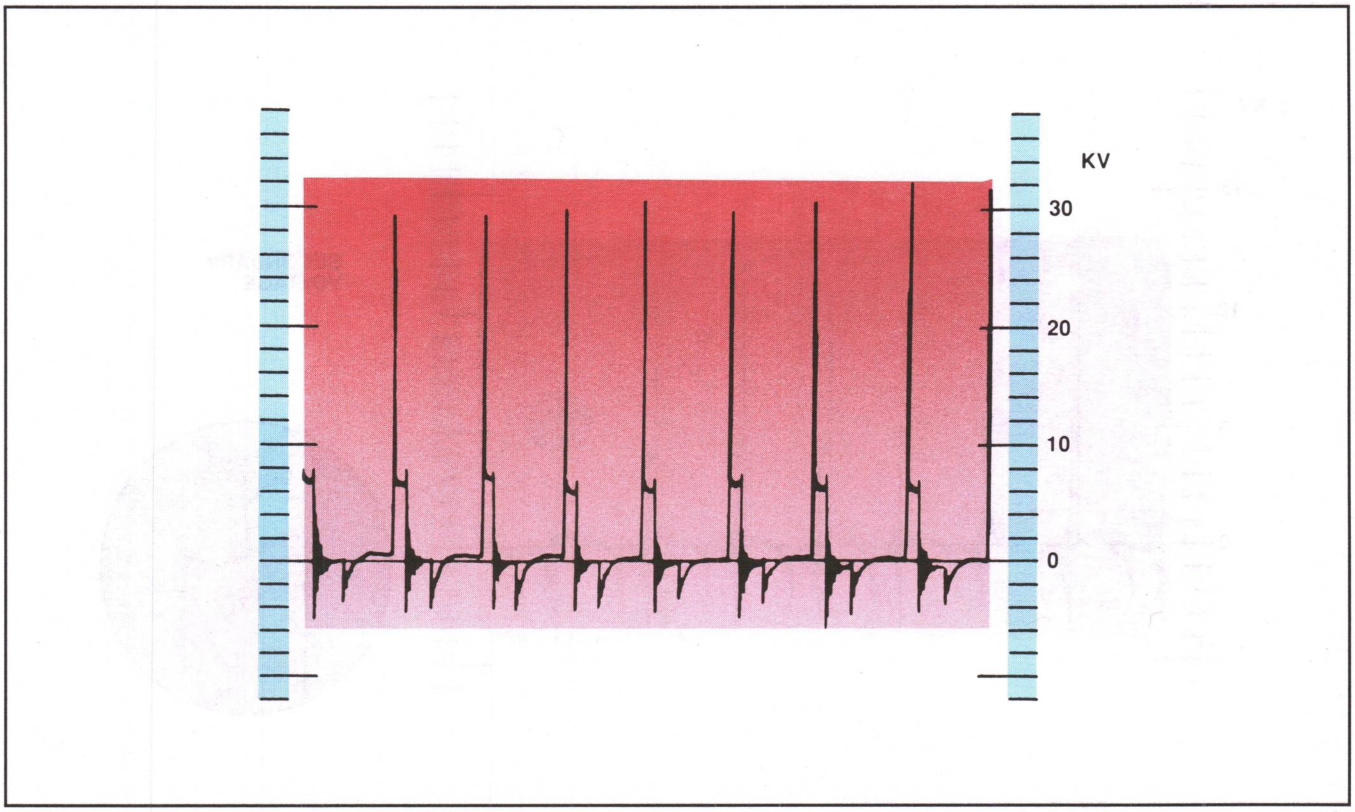


Figure 3-4 — Acceleration secondary voltage

During acceleration, compression pressures in the cylinder are very high. The ignition secondary voltage increases to overcome high compression pressures.

Example

Understanding the relationships between engine conditions and ignition requirements increases your ability to accurately diagnose driveability concerns. A weak ignition coil, for example, may still provide adequate voltage for starting and idle operation. However, it may not provide adequate voltage for high speed operation, thereby causing a high speed **driveability** concern. If you were to check secondary voltage and spark duration at idle, you probably would not find a problem. You need to check the system with the engine running at higher speeds.

This is the end of Lesson 3. Continue with Lesson 4. The video tape and Progress Check questions have combined Lessons 3 and 4.

IGNITION SYSTEM THEORY AND OPERATION

Lesson **1** Spark and Ignition

Lesson **2** Basic Ignition

Lesson **3** Ignition Requirements and Operating Modes

Lesson **4** Ignition Related Driveability Symptoms

Lesson **5** Basic Testing

NAAO

Lesson **6** DI Ignition System

Lesson **7** EI – Low Data Rate Ignition System

Lesson **8** EI – High Data Rate Ignition System

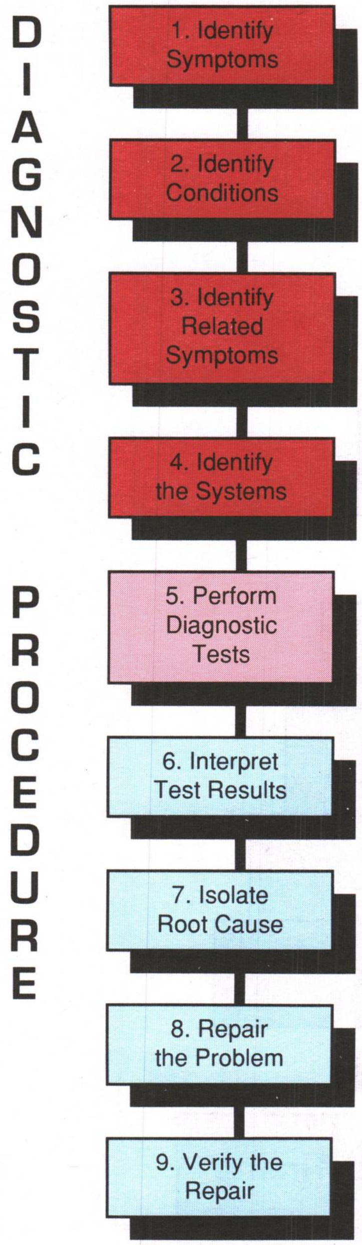
Lesson **9** EEC System Diagnosis

ASSOCIATION

Lesson **10** DI Electronically Controlled Timing

Lesson **11** DI Mechanically Controlled Timing

Lesson **12** Villager DI Ignition System



LESSON 4: IGNITION RELATED DRIVEABILITY SYMPTOMS

Where does this lesson fit into the diagnostic procedure?

The information in this lesson relates to steps 1, 2, 3 and 4 of the diagnostic procedure. For a driveability symptom to exist, one or more engine operating requirements are not being properly met. This lesson identifies the symptoms and conditions that can be caused by concerns with the ignition system.

Objective(s):

This lesson will enable you to identify the driveability symptoms commonly associated with the ignition system.

IGNITION CONDITIONS

There are four ignition related conditions that cause driveability symptoms:

- No spark
- Loss of spark
- Weak spark
- Improper spark timing

No Spark

No spark is the most severe ignition condition. No spark can be the result of malfunctions within either the primary or secondary sub-systems.

Loss of Spark

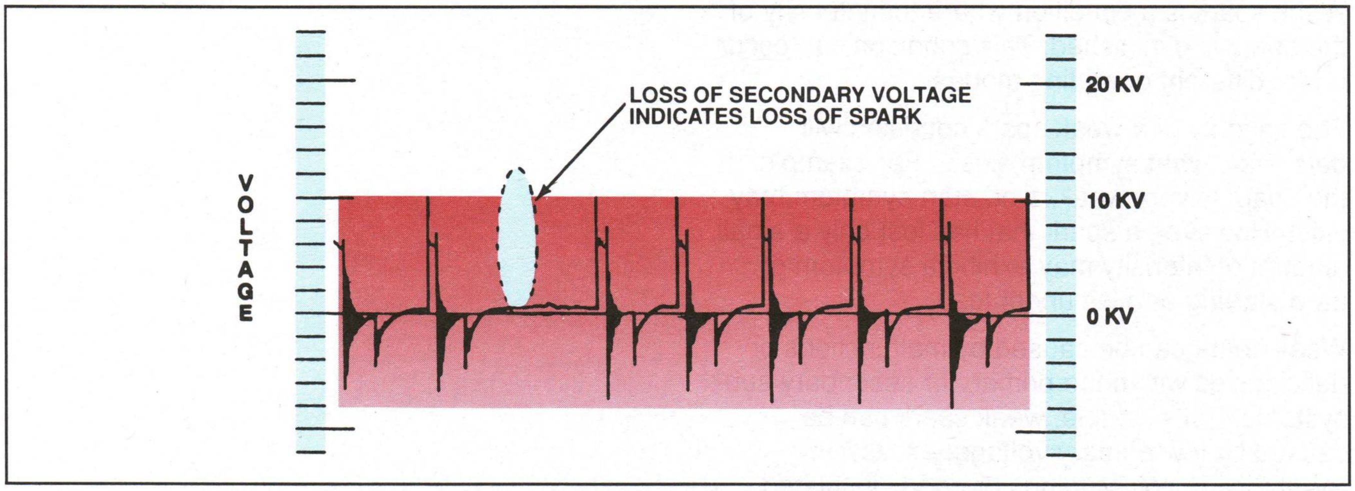


Figure 4-1 — Secondary scope pattern – loss of spark on cylinder 3

Loss of spark refers to a condition where the spark to one or more cylinders is lost **intermittently**. This can occur during different operating modes.

A loss of spark condition is typically due to malfunctions in the primary control system or deteriorated secondary distribution components.

The symptom that results depends on how often the condition occurs and how severe the condition is. For example, an intermittent loss of spark at idle would be perceived as a **miss** or rough idle. However, a loss of spark during cruise would be perceived as a buck or jerk.

Weak Spark

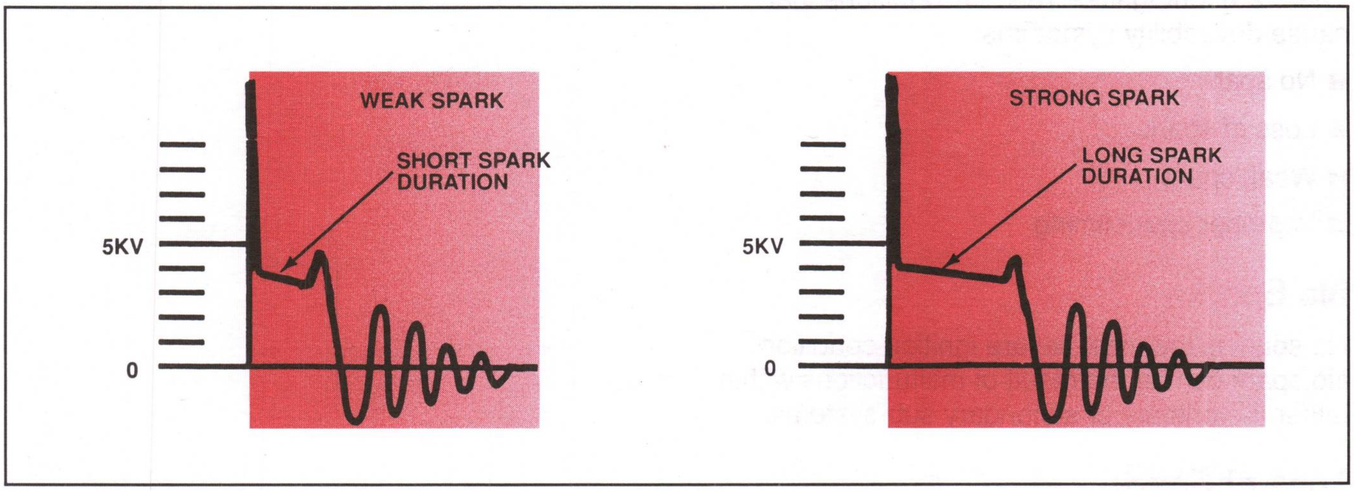


Figure 4-2 — Weak spark – all firing lines low

Weak spark is a condition where the intensity of the spark is diminished. This condition can occur under different operating modes.

The severity of a weak spark condition will determine what symptom exists. For example, if the spark is very weak, a no start symptom may exist. However, a spark that has lost only a small amount of intensity may exhibit a symptom of hard starting or miss under load.

Weak spark can be caused by malfunctions or deficiencies within the primary or secondary subsystems. For example, weak spark can be caused by low primary voltage, excessive resistance in coil windings or poorly insulated secondary.

Improper Spark Timing

Several symptoms can result from improper spark timing. The symptom which results depends on how often the condition occurs and how severe the condition is. For example, spark timing that fails to advance as engine speed increases may result in a lack of power.

IGNITION RELATED DRIVEABILITY SYMPTOMS

SYMPTOMS AND CONDITIONS

After verifying the symptom, begin the diagnostic process by identifying the conditions that can cause the symptom. The following chart identifies symptoms and their related conditions.

CONDITIONS

SYMPTOMS

	No Spark	Loss of Spark	Weak Spark	Timing
No Start	✓		✓	✓
Hard Start			✓	✓
Quits After Start		✓		
Stalls		✓		✓
Idle-Fast/slow				✓
Misses/Rough Run		✓	✓	
Buck/Jerk		✓	✓	
Stumble			✓	
Induction Backfire				✓
Loss of Power			✓	✓
Spark Knock				✓
Poor Fuel Economy*		✓	✓	✓
Excessive Emissions*		✓	✓	✓

* In most instances other symptoms will be present.

This is the end of Lesson 4. Now view Lessons 3 and 4 on the video tape. Then answer the Progress Check questions.

LESSON 3 AND 4 – PROGRESS CHECK QUESTIONS

The following questions are based on the information contained in Lesson 3 and Lesson 4. Choose the **ONE** best correct answer. The answers are provided on the following page. Review any questions missed before proceeding to the next lesson.

1. The FOUR engine operating modes that affect the ignition system are:
   A. idle, cruise, acceleration and braking.
   B. starting, stopping, coasting and accelerating.
   C. cruising, coasting, braking and accelerating.
   D. starting, idling, cruising and accelerating.

2. Technician A says that higher secondary ignition voltage is required during acceleration than during idle. Technician B says that adequate spark duration is critical during cruise. Who is correct?
   A. Technician A
   B. Technician B
   C. Both A and B
   D. Neither A nor B

3. Technician A says that a weak ignition coil could cause a buck/jerk symptom during cruise or acceleration. Technician B says that if a coil is weak, the engine will always perform poorly in all operating modes. Who is correct?
   A. Technician A
   B. Technician B
   C. Both A and B
   D. Neither A nor B

LESSON 3 AND 4 – PROGRESS CHECK ANSWERS

1. The four engine operating modes that affect the ignition system are:
   A. idle, cruise, acceleration and braking.
   B. starting, stopping, coasting and accelerating.
   C. cruising, coasting, braking and accelerating.
   [✓ D.] starting, idling, cruising and accelerating.

2. Technician A says that higher secondary ignition voltage is required during acceleration than during idle. Technician B says that adequate spark duration is critical during cruise. Who is correct?
   A. Technician A
   B. Technician B
   [✓ C.] Both A and B
   D. Neither A nor B

   Higher voltage is required during acceleration because of the higher compression pressures. Good spark duration is essential for proper combustion during cruise due to leaner air/fuel mixtures.

3. Technician A says that a weak ignition coil could cause a buck/jerk symptom during cruise or acceleration. Technician B says that if a coil is weak the engine will always perform poorly in all operating modes. Who is correct?
   [✓ A.] Technician A
   B. Technician B
   C. Both A and B
   D. Neither A nor B

   A weak coil could cause a buck/jerk symptom. However, a weak coil can still function well enough to provide good performance under low load conditions such as starting or idle.

LESSON 3 AND 4 – PROGRESS CHECK QUESTIONS (CONT'D.)

4. Technician A says that when diagnosing a driveability concern you should first identify the conditions that can be responsible for the concern. Technician B says that no spark, loss of spark, weak spark and improper spark timing are the ignition system related conditions that can cause driveability concerns, or symptoms. Who is correct?

   A. Technician A

   B. Technician B

   C. Both A and B

   D. Neither A nor B

5. An intermittent loss of spark can be due to:

   A. an open in the coil's primary winding power supply circuit.

   B. a short in the coil's primary winding power supply circuit.

   C. erratic primary switching control inside the ICM.

   D. an open in the spark plug.

6. Which of the following symptoms can be caused by a weak spark?

   A. Idle too slow

   B. Hard start

   C. Idle too fast

   D. Spark knock

LESSON 3 AND 4 – PROGRESS CHECK ANSWERS (CONT'D.)

4. Technician A says that when diagnosing a driveability concern you should first identify the conditions that can be responsible for the concern. Technician B says that no spark, loss of spark, weak spark and improper spark timing are the ignition system related conditions that can cause driveability concerns, or symptoms. Who is correct?

   A. Technician A
   B. Technician B
   [✓ C.] Both A and B
   D. Neither A nor B

   You should always go through a diagnostic thought process which identifies the relationships between the symptom(s) and the causal conditions. Then you should identify the systems and components that are most likely responsible for those conditions. No spark, loss of spark, weak spark and improper spark timing are the conditions that can be created by ignition system malfunctions.

5. An intermittent loss of spark can be due to:

   A. an open in the coil's primary winding power supply circuit.
   B. a short in the coil's primary winding power supply circuit.
   [✓ C.] erratic primary switching control inside the ICM.
   D. an open in the spark plug.

   A loss of spark refers to a condition where the spark is lost intermittently during certain operating modes. Therefore, the malfunction must be one that occurs on an intermittent basis. The other faults identified would not create an intermittent loss of spark condition.

6. Which of the following symptoms can be caused by a weak spark?

   A. Idle too slow
   [✓ B.] Hard start
   C. Idle too fast
   D. Spark knock

   If spark intensity is too weak, hard starting can occur. It may take several engine revolutions before combustion is achieved. Other conditions are necessary to produce the other symptoms listed.

LESSON 3 AND 4 – PROGRESS CHECK QUESTIONS (CONT'D.)

7. Technician A says that a lack of power symptom can be the result of improper spark timing. Technician B says that improper timing can cause poor fuel economy. Who is right?

   A. Technician A

   B. Technician B

   C. Both A and B

   D. Neither A nor B

LESSON 3 AND 4 – PROGRESS CHECK ANSWERS (CONT'D.)

7. Technician A says that a lack of power symptom can be the result of improper spark timing. Technician B says that improper timing can cause poor fuel economy. Who is right?

   A. Technician A

   B. Technician B

   [✓ C.] Both A and B

   D. Neither A nor B

   Lack of power and poor fuel economy can result from improper base timing or improper timing control.

IGNITION SYSTEM THEORY AND OPERATION

Lesson 1 Spark and Ignition

Lesson 2 Basic Ignition

Lesson 3 Ignition Requirements and Operating Modes

Lesson 4 Ignition Related Driveability Symptoms

Lesson 5 **Basic Testing**

NAAO

Lesson 6 DI Ignition System

Lesson 7 EI – Low Data Rate Ignition System

Lesson 8 EI – High Data Rate Ignition System

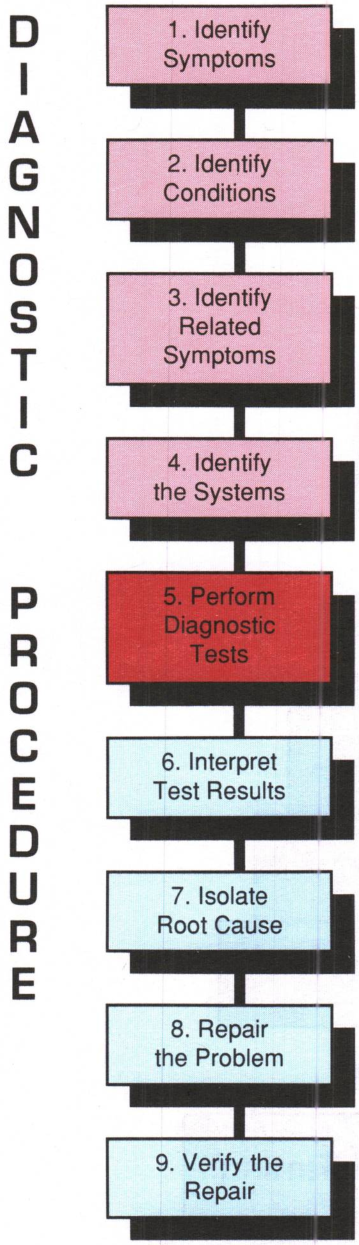
Lesson 9 EEC System Diagnosis

ASSOCIATION

Lesson 10 DI Electronically Controlled Timing

Lesson 11 DI Mechanically Controlled Timing

Lesson 12 Villager DI Ignition System



LESSON 5: BASIC TESTING

Where does this lesson fit into the diagnostic procedure?

The information in this lesson relates to step 5 of the diagnostic procedure.
It covers basic ignition system tests.

After symptoms and conditions have been identified, the next step in the diagnostic procedure is to identify the systems and components that could be responsible for the symptom. In order to isolate which system(s) and component(s) are responsible, tests must be performed.

This lesson introduces basic tests used to evaluate ignition primary, secondary and timing control subsystems. The tests described in this lesson are common to all ignition systems used on Ford, Lincoln and Mercury vehicles. Testing specific systems and components will be covered in later lessons.

NOTE: Although the tests described in this lesson are common to all systems, there are, in some instances, procedural and equipment variations. Always refer to the PCED and other appropriate service manuals for instructions and specifications.

Objective(s):

The information in this lesson will enable you to identify and describe ignition system diagnostic procedures and test equipment.

PRIMARY CIRCUIT TESTS

Common **primary circuit** tests include:

- General circuit condition
- Coil supply voltage
- Coil primary circuit ground
- Coil primary resistance
- Coil dwell – saturation

A quality ignition spark is only possible when the ignition coil is able to develop a strong magnetic field. The coil primary winding must have the correct resistance, a good voltage supply, proper saturation and a good ground.

General Circuit Condition

The first step should always be a visual inspection. A visual inspection can be used to identify loose connections, broken or burned wires, and corroded or damaged terminals.

Coil Supply Voltage

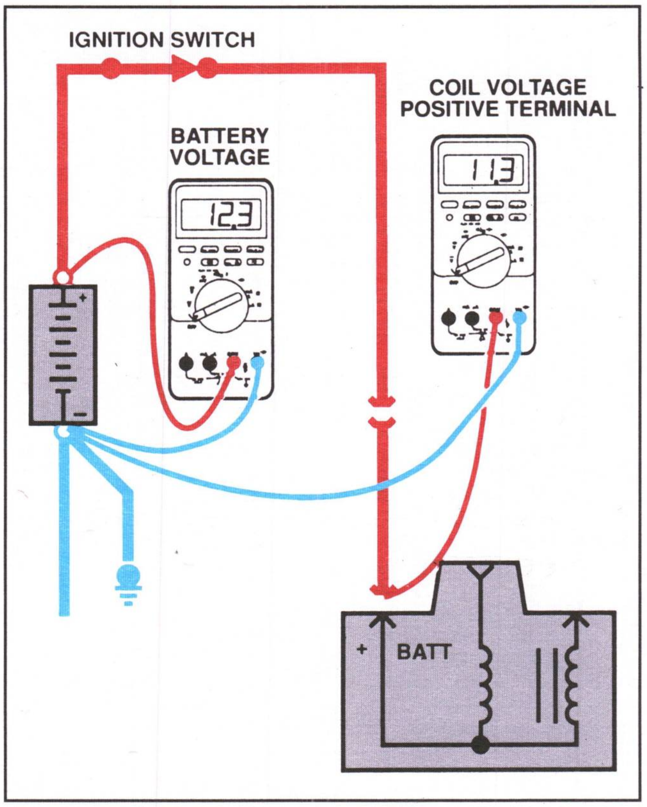


Figure 5-1 — Voltage supply test

When the ignition switch is closed, voltage to the ignition coil positive (+) terminal should be within one (1) volt of battery voltage.

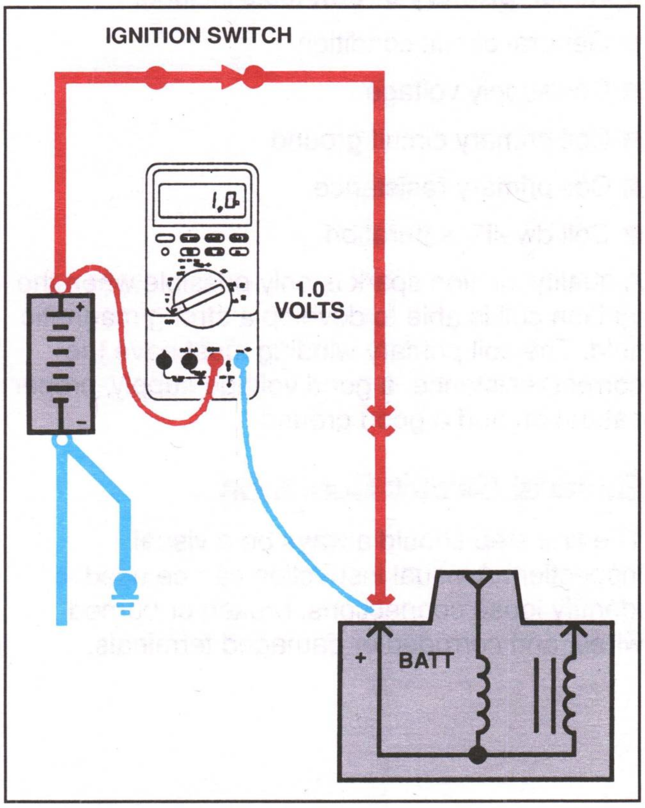


Figure 5-2 — Voltage drop test

A voltage drop test can be used to determine if there is excessive resistance in the supply circuit.

Coil Primary Circuit Ground

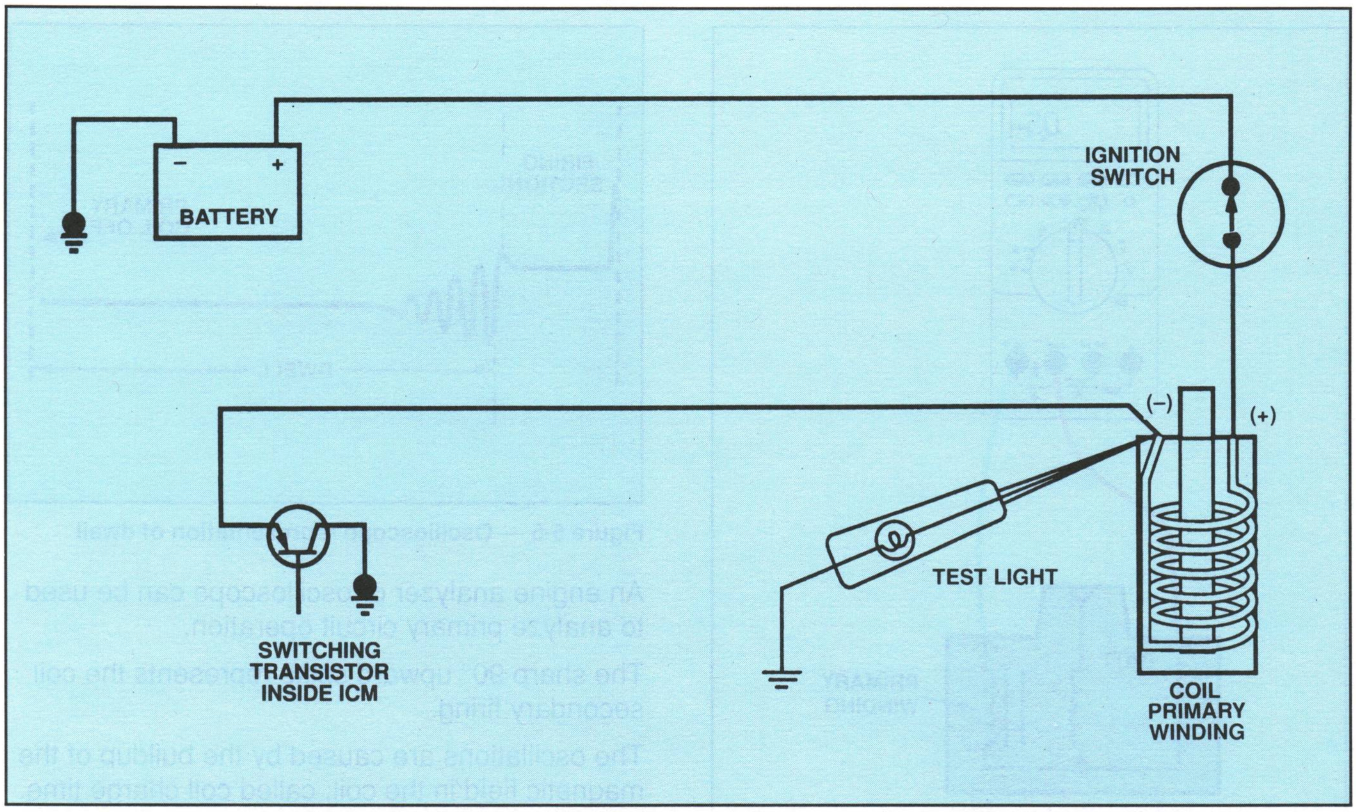


Figure 5-3 — Primary operation test

The coil primary circuit grounds through the ICM. When the circuit is grounded, voltage at the negative terminal of the coil will be close to 0 volts. When the circuit is open, voltage should be close to battery voltage.

During cranking, a test light will blink ON and OFF as the ICM grounds and un-grounds primary current. If the test light stays ON, the primary ground is open. If the light does not come on, either the ICM is not opening the primary ground or there is an open in the primary voltage supply circuit.

Coil Primary Resistance

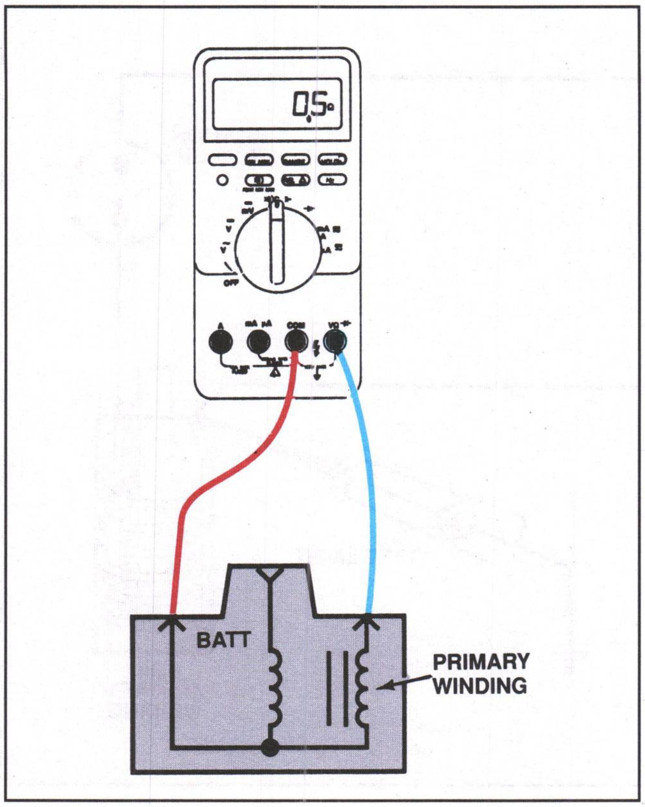


Figure 5-4 — Primary resistance test

Coil primary resistance is measured with an ohmmeter. Coil temperature can affect the resistance of the winding. When possible, the winding should be at room temperature when tested.

Refer to the "Ignition Systems" section in the PCED manual for specific instructions and specifications for the vehicle being serviced.

Coil Dwell – Saturation

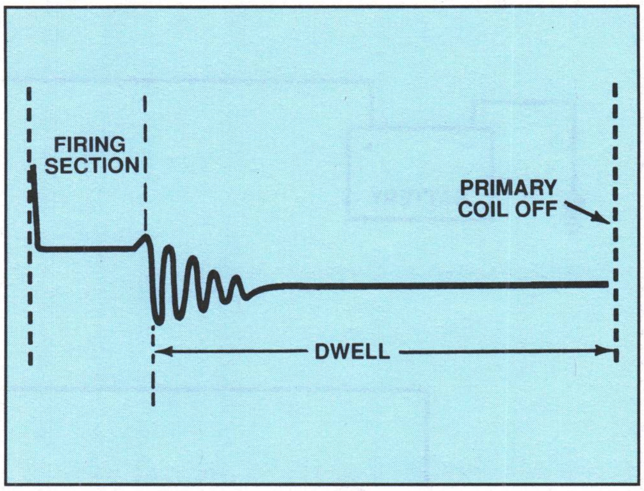


Figure 5-5 — Oscilloscope representation of dwell

An engine analyzer or oscilloscope can be used to analyze primary circuit operation.

The sharp 90° upward spike represents the coil secondary firing.

The oscillations are caused by the buildup of the magnetic field in the coil, called coil charge time.

The straight line along the zero line represents the saturation time (typically 3 ms).

The **SBDS** cart is also capable of testing the primary ignition. Refer to the SBDS operating instructions for applicable tests on the vehicle being serviced.

SECONDARY CIRCUIT TESTS

The following information and secondary tests are common to all ignition systems:

- General circuit condition
- Coil secondary resistance
- Secondary wire resistance
- Secondary required voltage
- Spark duration
- Reading spark plug condition

Conditions of no spark or weak spark could be the result of concerns with the secondary subsystem. Symptoms such as missing or buck/jerk, for example, could be caused by shorts or opens in plug wires. A hard starting symptom caused by weak spark, for example, could be the result of bad secondary windings.

General Circuit Condition

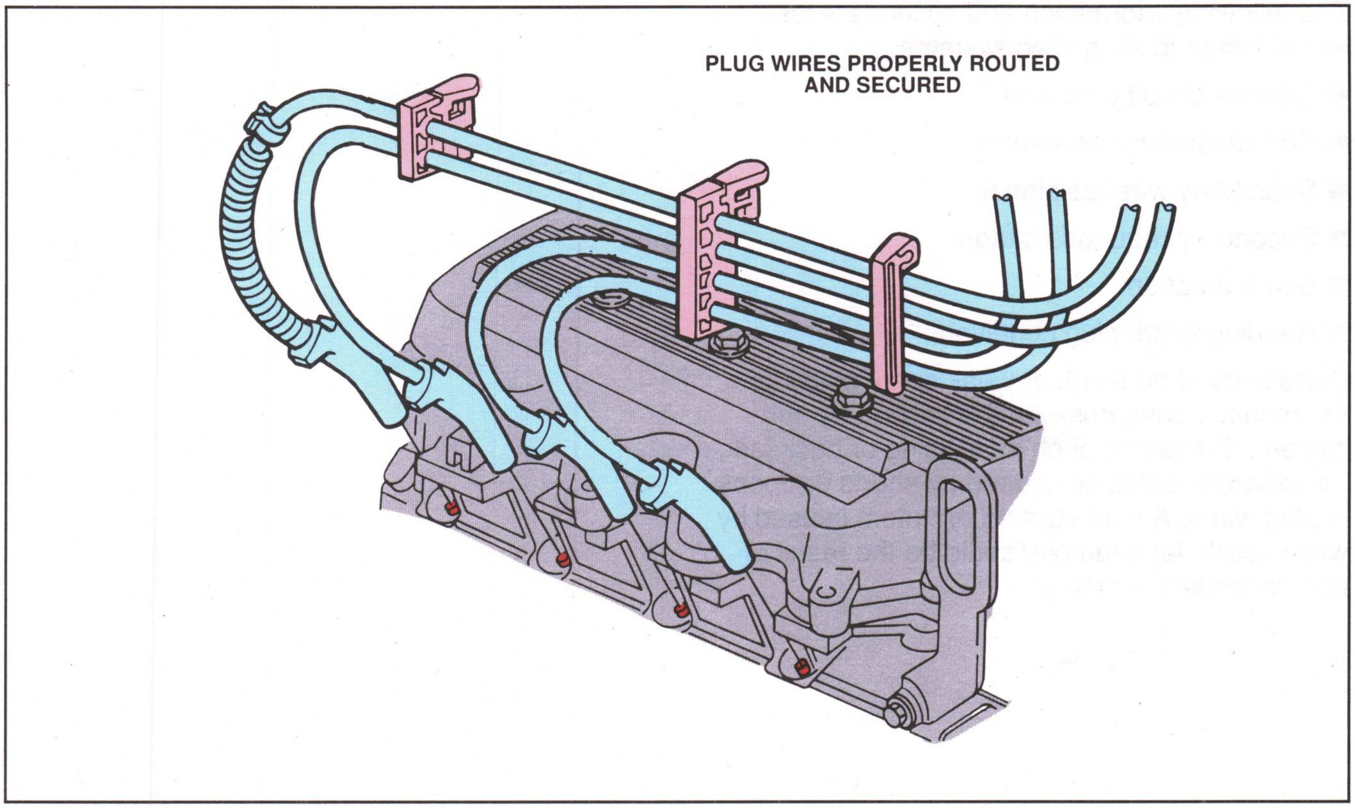


Figure 5-6 — Plug wire routing

During a general circuit inspection, make sure all secondary wires are fully seated. They should be properly routed to the correct spark plugs for the engine's **firing order**. Also, secondary wires should be routed to avoid contact with metal and with each other whenever possible. When wires contact each other, induction cross fire can occur. This is a concern where high secondary voltage in one wire is induced into another wire. This results in a loss of spark. Avoid contact with exhaust manifolds and moving parts that could damage the wires. Inspect the condition of the secondary wires. Wires that have worn, torn or damaged insulation could allow secondary voltage to leak. Wires in this condition should be replaced.

Coil Secondary Resistance Tests

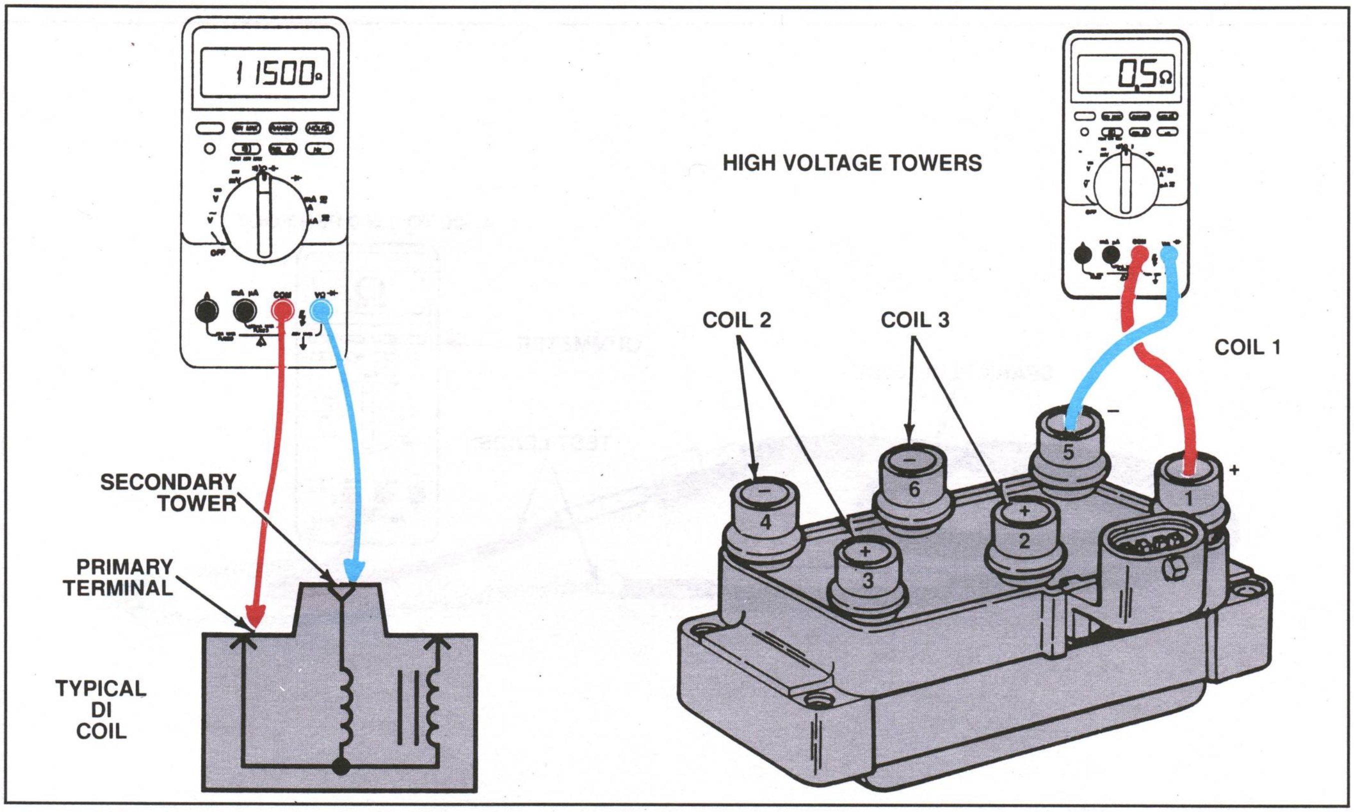


Figure 5-7 — Secondary resistance test

Coil secondary resistance is measured with an **ohmmeter**. Refer to the “Ignition Systems” section in the PCED manual and the vehicle’s shop manual for testing instructions.

Secondary Wire Resistance Tests

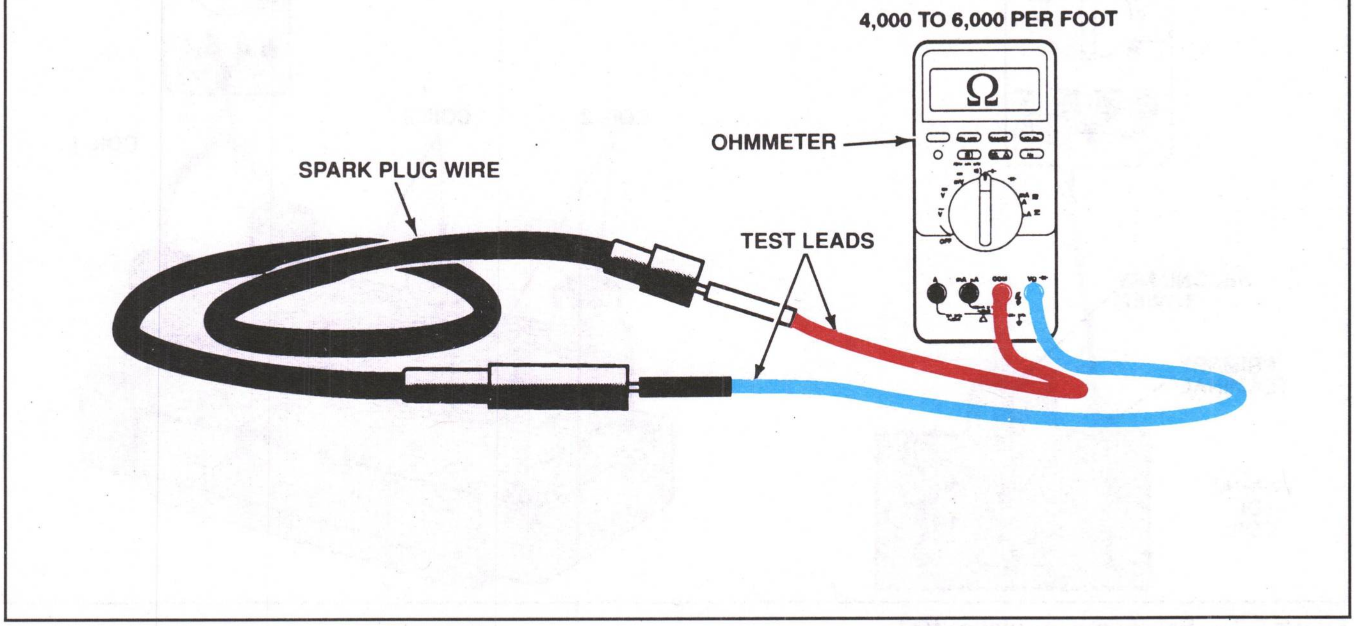


Figure 5-8 — Secondary wire resistance test

Secondary wire resistance is measured with an ohmmeter. Resistance is typically between 4,000 and 6,000 **ohms** per foot.

Secondary Required Voltage Tests

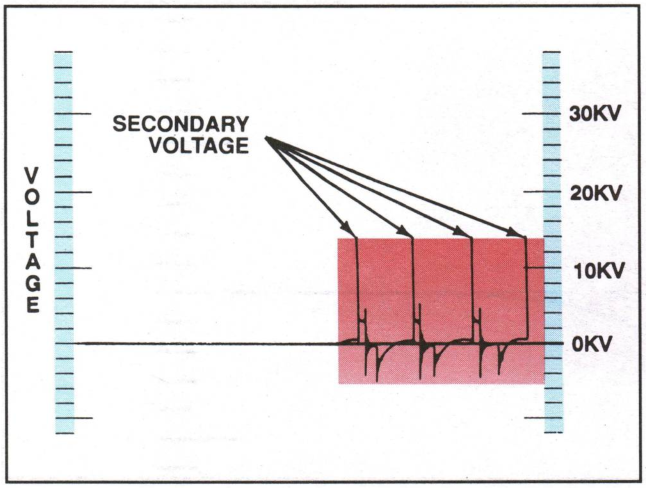


Figure 5-9 — Secondary required voltage

Secondary required voltage is the amount of voltage required to fire the spark plug. To perform this test, an engine oscilloscope is used while the engine is running. The required voltage for each cylinder should be about the same (within 3 Kv).

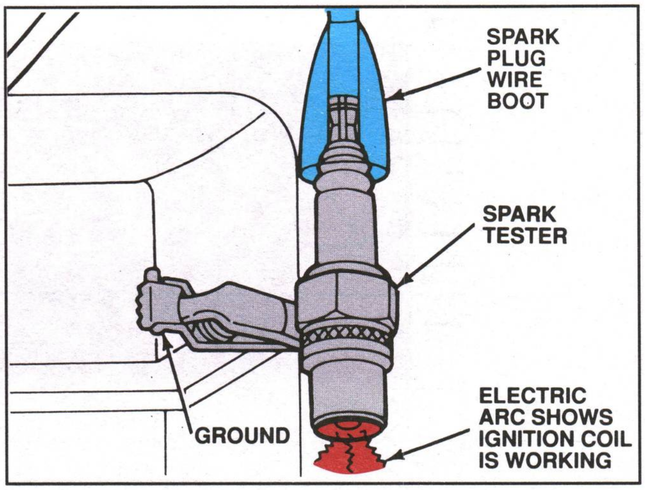


Figure 5-10 — Spark test

In the case of a no start, a spark tester is a quick method of determining if adequate secondary voltage is present. Insert the tester in the plug wire boot, crank the engine and check for spark.

Refer to the PCED manual for the recommended spark tester and tool number.

Spark Duration Tests

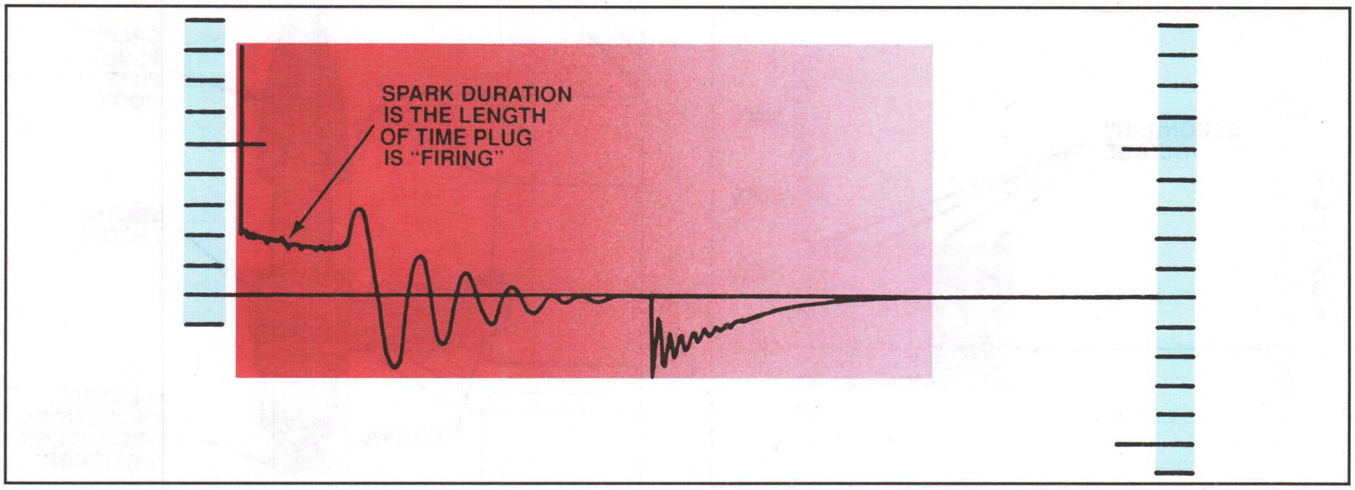


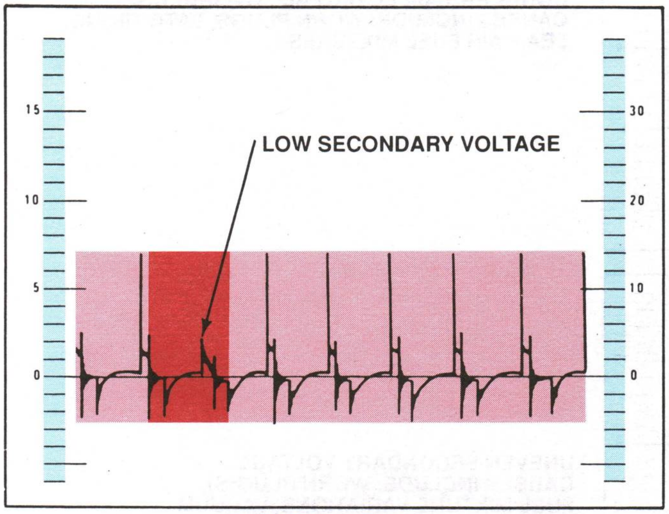
Figure 5-11 — Secondary operation

Spark duration is a good indicator of ignition strength. An ignition system that can produce a spark duration of 1.0 ms or more has enough strength to properly ignite an air/fuel mixture. This test is performed with an engine analyzer.

The SBDS cart can be used to perform a spark duration test. Refer to the cart's operating instructions for details.

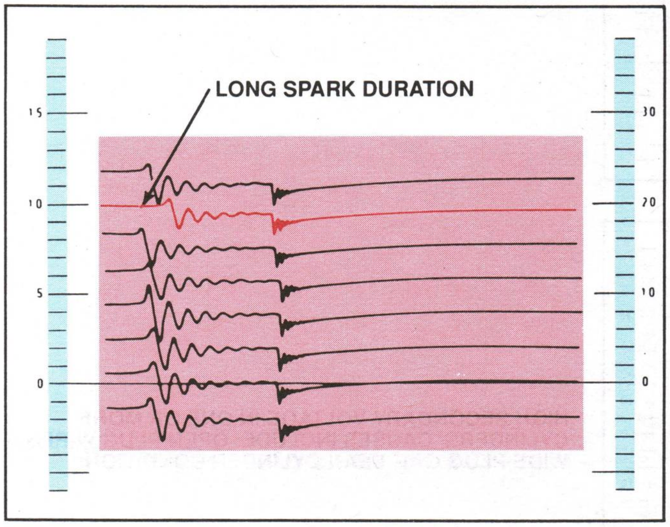
SCOPE PATTERNS

Study the following examples of bad scope patterns. Note the relationships between the patterns and the conditions listed as possible causes. Remember that air/fuel ratios affect secondary voltage requirements.



PARADE DISPLAY

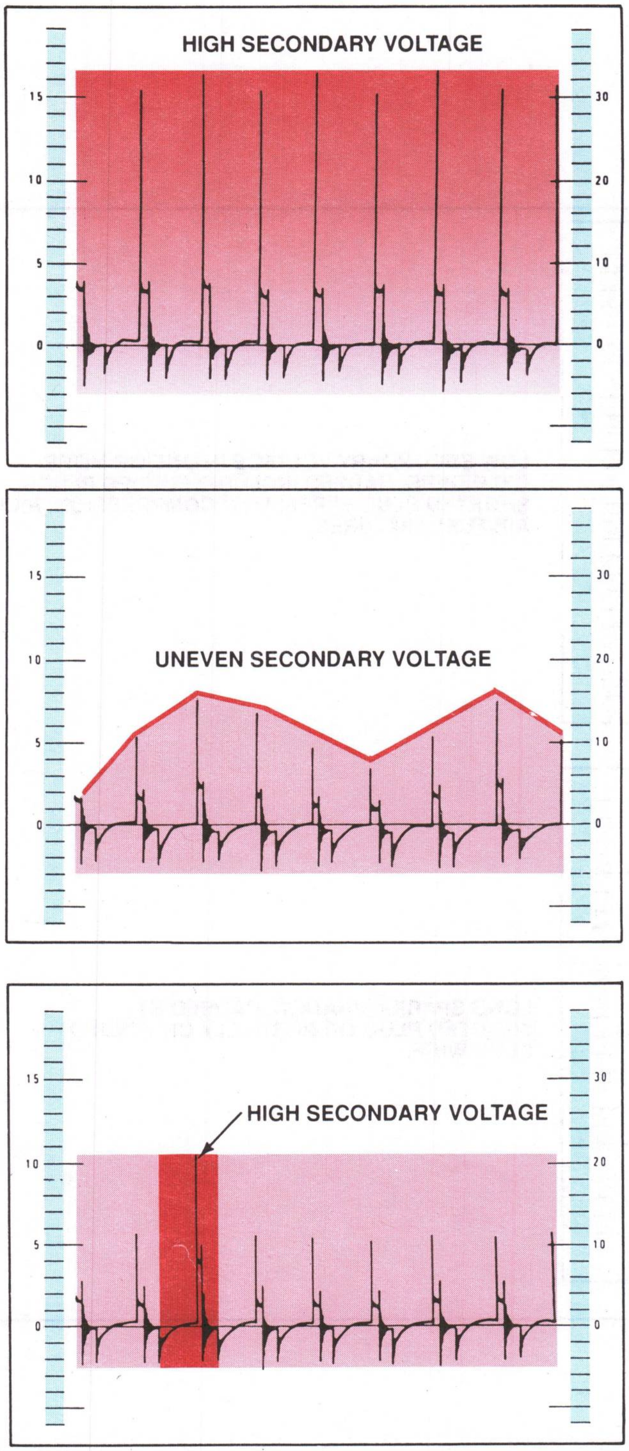
LOW SECONDARY VOLTAGE IN ONE OR MORE CYLINDERS. CAUSES INCLUDE: FOULED PLUGS, SHORTED PLUG WIRES, LOW COMPRESSION, RICH AIR/FUEL MIXTURES.



RASTER DISPLAY

LONG SPARK DURATION. CAUSED BY SHORTED PLUG OR PARTIALLY GROUNDED PLUG WIRE.

Figure 5-12 — Scope patterns



HIGH EVEN SECONDARY VOLTAGE INDICATES CONCERNS AFFECTING ALL CYLINDERS. CAUSES INCLUDE: WORN PLUGS, LATE TIMING, LEAN AIR/FUEL MIXTURES.

UNEVEN SECONDARY VOLTAGE. CAUSES INCLUDE: WORN PLUG(S), FUEL MIXTURE VARIATIONS, VACUUM LEAKS, UNEVEN COMPRESSION.

HIGH SECONDARY VOLTAGE IN ONE OR MORE CYLINDERS. CAUSES INCLUDE: OPEN PLUG WIRES, WIDE PLUG GAP, LEAN CYLINDER CONDITION.

Figure 5-13 — Scope patterns

READING SPARK PLUG CONDITION

Engine conditions may be identified by visually inspecting spark plugs. The ability to evaluate their appearance improves diagnostic accuracy and speed.

Normal Wear

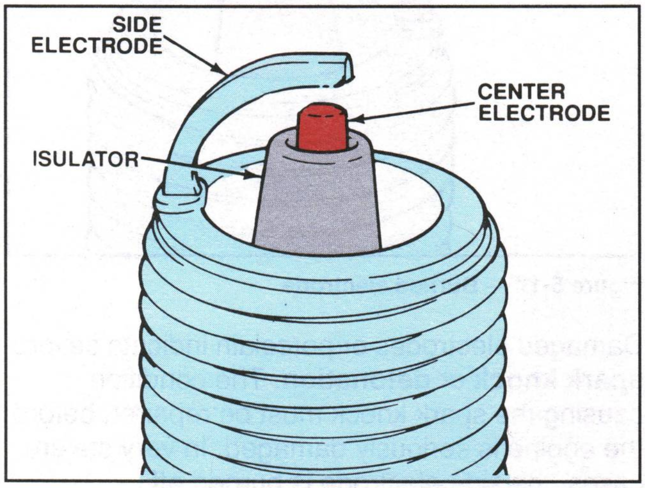


Figure 5-14 — Normal wear

The center electrode insulator on spark plugs with normal wear will be tan or light brown. To check for wear, look closely at the shape of the center electrode. New spark plugs have a flat center electrode with sharp edges. A worn spark plug has rounded edges. Rounded edges increase required secondary voltage and decrease spark duration.

Air Gap

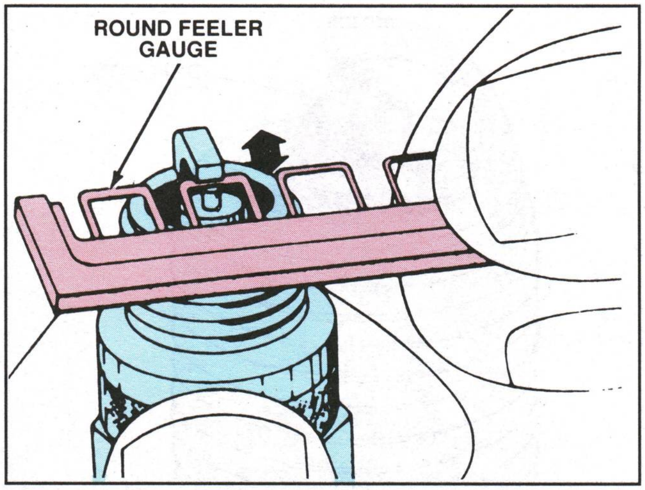


Figure 5-15 — Air gap check

Check the air gap with a wire (round) feeler gauge. The air gap is adjusted by bending the side electrode. All spark plugs should be adjusted to specifications.

Fouled Spark Plugs

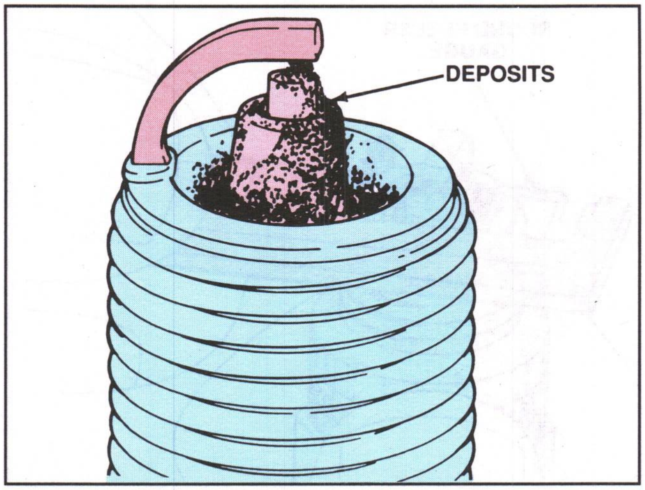


Figure 5-16 — Plug deposits

A fouled spark plug is one that is covered with fuel, oil or **carbon** deposits. Fouled spark plugs do not create a proper spark because the electrons flow through the deposits rather than across the air gap.

Oil fouled spark plugs usually indicate an engine oil control problem. Oil entering the combustion chamber past the **piston rings** will usually leave deposits around the entire spark plug area.

A spark plug with carbon buildup on one side of the center electrode usually indicates an oil control problem with the **intake valves**.

Detonation Damage

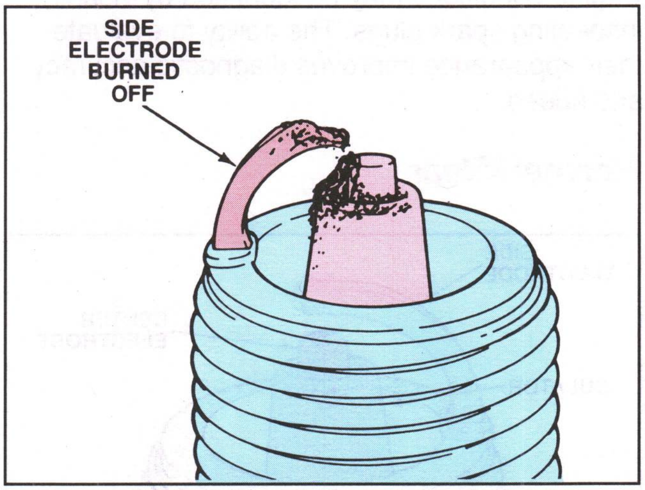


Figure 5-17 — Burned electrode

Damaged electrodes or porcelain indicate severe **spark knock** or **detonation**. The condition causing the spark knock must be repaired before the engine is seriously damaged. In very severe cases, the side electrode is burned off.

NOTE: During installation, spark plugs must be torqued to specifications. Proper **torque** provides a good path for heat transfer from the spark plug to the cylinder head.

IGNITION TIMING

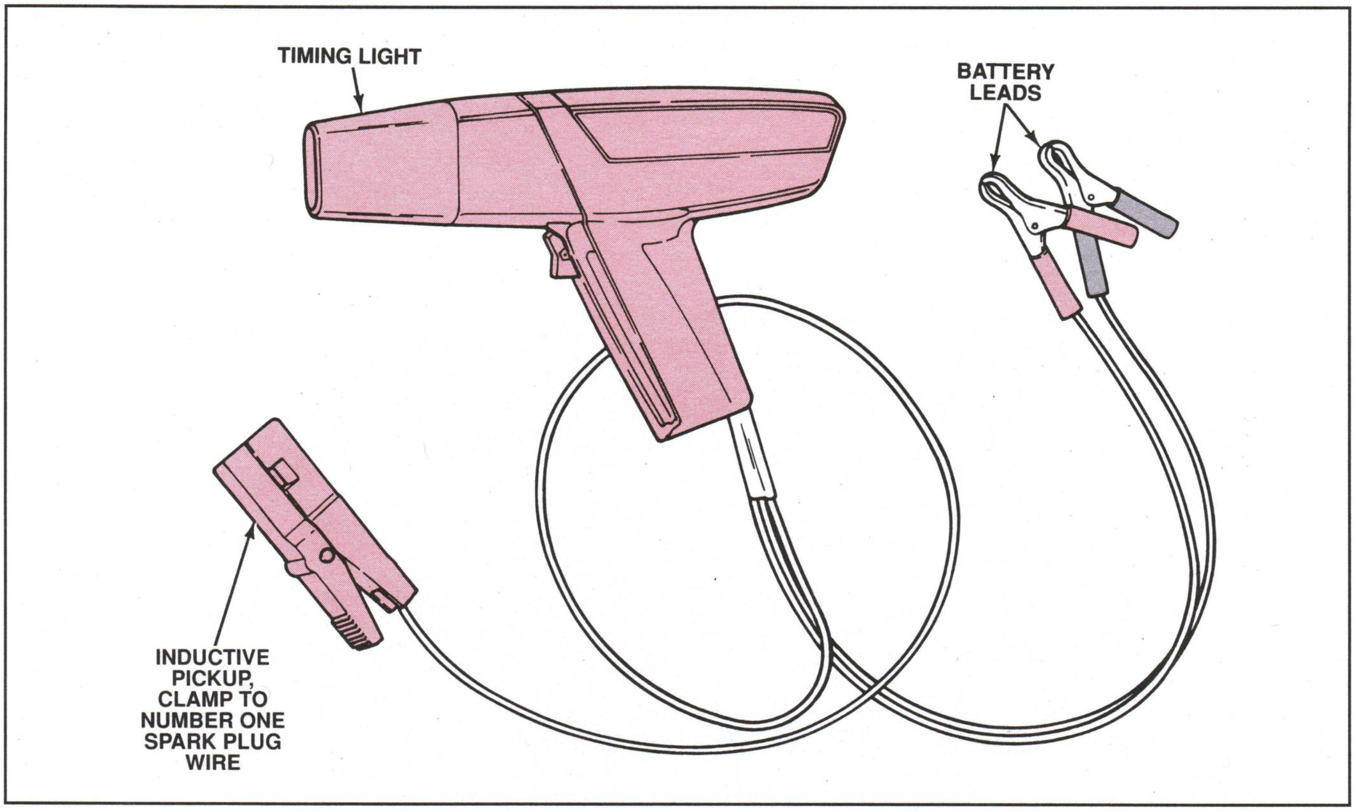


Figure 5-18 — Timing light

Base engine timing is checked with a timing light. To check base engine timing, connect the inductive pick-up to the secondary wire leading to the #1 cylinder. Connect the other two leads to the battery.

Start the engine, and point the timing light at the timing marks.

Follow procedures in the PCED manual for other steps required to test base engine timing.

NOTE: Timing test procedures for each of the ignition systems will be covered more thoroughly in their respective lessons.

This is the end of Lesson 5. Now view Lesson 5 on the video tape, and answer the Progress Check questions.

LESSON 5 – PROGRESS CHECK QUESTIONS

The following questions are based on the information contained in Lesson 5. Choose the **ONE** best correct answer. The answers are provided on the following page. Review any questions missed before proceeding to the next lesson.

1. Technician A says that the first test to perform on the ignition system is always coil primary available voltage. Technician B says that before performing any diagnostic tests you should perform a visual inspection of the system. Who is right?

   A. Technician A

   B. Technician B

   C. Both A and B

   D. Neither A nor B

2. To check the available voltage to the primary terminal of the ignition coil, you:

   A. use a DVOM with the positive lead connected to battery positive and the negative lead connected to ground.

   B. use a DVOM with the positive lead connected to battery positive and the negative lead connected to the positive terminal of the coil.

   C. use a DVOM with the positive lead connected to a battery voltage supply source and the negative lead connected to the negative terminal of the coil.

   D. use a DVOM with the positive lead connected to the positive terminal of the coil and the negative lead connected to ground.

3. To check for voltage drop at the coil's power supply terminal you:

   A. use a DVOM and connect the positive lead to the negative terminal of the battery and the negative lead to the negative terminal of the coil.

   B. use a DVOM with the positive lead connected to the positive terminal of the battery and the negative lead connected to the positive terminal of the coil.

   C. use a DVOM with the positive lead connected to the positive terminal of the battery and the negative lead connected to the secondary coil tower.

   D. Use a test 12 volt test light connected between ground and the negative terminal of the coil.

LESSON 5 – PROGRESS CHECK ANSWERS

1. Technician A says that the first test to perform on the ignition system is always coil primary available voltage. Technician B says that before performing any diagnostic tests you should perform a visual inspection of the system. Who is right?

   A. Technician A
   [✓ B.] Technician B
   C. Both A and B
   D. Neither A nor B

   You should always perform a visual inspection before proceeding to other diagnostic tests.

2. To check the available voltage to the primary terminal of the ignition coil, you:

   A. use a DVOM with the positive lead connected to battery positive and the negative lead connected to ground.
   B. use a DVOM with the positive lead connected to battery positive and the negative lead connected to the positive terminal of the coil.
   C. use a DVOM with the positive lead connected to a battery voltage supply source and the negative lead connected to the negative terminal of the coil.
   [✓ D.] use a DVOM with the positive lead connected to the positive terminal of the coil and the negative lead connected to ground.

   This procedure gives the volt drop to prove potential voltage to the coil.

3. To check for voltage drop at the coil's power supply terminal you:

   A. use a DVOM and connect the positive lead to the negative terminal of the battery and the negative lead to the negative terminal of the coil.
   [✓ B.] use a DVOM with the positive lead connected to the positive terminal of the battery and the negative lead connected to the positive terminal of the coil.
   C. use a DVOM with the positive lead connected to the positive terminal of the battery and the negative lead connected to the secondary coil tower.
   D. Use a test 12 volt test light connected between ground and the negative terminal of the coil.

   Voltage drop identifies the loss of voltage from resistance in the circuit.

LESSON 5 – PROGRESS CHECK QUESTIONS (CONT'D.)

4. Technician A says that performing a voltage drop test between the coil positive terminal and the positive terminal of the battery can detect resistance problems with the coil's power supply circuit. Technician B says that when a voltage drop test is performed between the positive terminal of the battery and the positive terminal of the coil, the voltage reading displayed on the DVOM should be 1.0 volt or less. Who is correct?

   A. Technician A

   B. Technician B

   C. Both A and B

   D. Neither A nor B

5. What is a quick and easy test to perform to see if the primary ignition system is functioning?

   A. Connect a 12 volt test light between ground and the negative terminal of the coil. Crank the engine, and observe the light.

   B. Connect a 12 volt test light between the positive terminal of the coil and ground. Crank the engine, and observe the light.

   C. Connect a 12 volt test light between the positive terminal of the battery and the negative terminal of the battery. Crank the engine, and observe the light.

   D. Connect a self powered test light between the negative terminal of the coil and ground. Crank the engine, and observe the light.

6. Technician A says that the ICM provides the ground circuit for the coil's primary circuit. Technician B says that the ICM must have good power and ground supplies of its own. Who is right?

   A. Technician A

   B. Technician B

   C. Both A and B

   D. Neither A nor B

LESSON 5 – PROGRESS CHECK ANSWERS (CONT'D.)

4. Technician A says that performing a voltage drop test between the coil positive terminal and the positive terminal of the battery can detect resistance problems with the coil's power supply circuit. Technician B says that when a voltage drop test is performed between the positive terminal of the battery and the positive terminal of the coil, the voltage reading displayed on the DVOM should be 1.0 volt or less. Who is correct?

   A. Technician A

   B. Technician B

   [✓ C.] Both A and B

   D. Neither A nor B

   A voltage drop test is used to determine if there is excessive resistance in a circuit. Typically, no more than one volt should be dropped, or used, by the conductors of a circuit. Voltage should only be dropped across the loads of a circuit.

5. What is a quick and easy test to perform to see if the primary ignition system is functioning?

   [✓ A.] Connect a 12 volt test light between ground and the negative terminal of the coil. Crank the engine, and observe the light.

   B. Connect a 12 volt test light between the positive terminal of the coil and ground. Crank the engine, and observe the light.

   C. Connect a 12 volt test light between the positive terminal of the battery and the negative terminal of the battery. Crank the engine, and observe the light.

   D. Connect a self powered test light between the negative terminal of the coil and ground. Crank the engine, and observe the light.

   If the primary circuit is operating properly the test light will blink.

6. Technician A says that the ICM provides the ground circuit for the coil's primary circuit. Technician B says that the ICM must have good power and ground supplies of its own. Who is right?

   A. Technician A

   B. Technician B

   [✓ C.] Both A and B

   D. Neither A nor B

   The ICM does provide the ground for the coil's primary circuit; and it must have proper power and ground supplies itself in order to function properly.

LESSON 5 – PROGRESS CHECK QUESTIONS (CONT'D.)

7. Technician A says that a DVOM with the negative lead connected to the negative terminal of the battery and the positive lead connected to the ground circuit of the ICM will test the integrity of the ICM ground. Technician B says that there is no reason to perform a voltage drop test on a ground circuit. Who is right?

   A. Technician A

   B. Technician B

   C. Both A and B

   D. Neither A nor B

8. What would most likely cause the side electrode of a spark plug to burn off?

   A. Leaky valve seals

   B. Rich air/fuel mixture

   C. Excessively advanced spark timing

   D. Excessively retarded spark timing

9. Technicians A and B are viewing a parade scope pattern. All the firing lines are at 31 Kv. Technician A says that this can be caused by a rich air/fuel mixture. Technician B says that high firing lines on all cylinders cannot be caused by an open plug wire. Who is right?

   A. Technician A

   B. Technician B

   C. Both A and B

   D. Neither A nor B

LESSON 5 – PROGRESS CHECK ANSWERS (CONT'D.)

7. Technician A says that a DVOM with the negative lead connected to the negative terminal of the battery and the positive lead connected to the ground circuit of the ICM will test the integrity of the ICM ground. Technician B says that there is no reason to perform a voltage drop test on a ground circuit. Who is right?

   [✓ A.] Technician A
   B. Technician B
   C. Both A and B
   D. Neither A nor B

   The test technician A describes is a voltage drop test used to diagnose the condition of the ICM ground circuit. The best way to check the integrity of a ground circuit is by performing a voltage drop test. In order for circuits to function properly they must contain good grounds. They should therefore be checked.

8. What would most likely cause the side electrode of a spark plug to burn off?

   A. Leaky valve seals
   B. Rich air/fuel mixture
   [✓ C.] Excessively advanced spark timing
   D. Excessively retarded spark timing

   Timing that is too advanced will cause detonation rather than even flame propagation. Detonation causes extremely high temperatures in the cylinder.

9. Technicians A and B are viewing a parade scope pattern. All the firing lines are at 31 Kv. Technician A says that this can be caused by a rich air/fuel mixture. Technician B says that high firing lines on all cylinders cannot be caused by an open plug wire. Who is right?

   A. Technician A
   [✓ B.] Technician B
   C. Both A and B
   D. Neither A nor B

   Rich air/fuel mixtures reduce the resistance in the combustion chamber, thereby lowering the voltage requirements of the ignition system. An open plug wire affects one specific cylinder. Since the firing lines on all the cylinders are high, the problem must be due to a condition affecting all cylinders.

LESSON 5 – PROGRESS CHECK QUESTIONS (CONT'D.)

10. Technicians A and B are viewing a parade scope pattern. Technician A says that a long spark line means that spark is occurring for a long period of time. Technician B says that an abnormally long spark line could be due to a shorted spark plug or a partially grounded plug wire. Who is correct?

    A. Technician A
    B. Technician B
    C. Both A and B
    D. Neither A nor B

LESSON 5 – PROGRESS CHECK ANSWERS (CONT'D.)

10. Technicians A and B are viewing a parade scope pattern. Technician A says that a long spark line means that spark is occurring for a long period of time. Technician B says that an abnormally long spark line could be due to a shorted spark plug or a partially grounded plug wire. Who is correct?

    A. Technician A

    B. Technician B

    [✓ C.] Both A and B

    D. Neither A nor B

    Both technicians are correct. Refer to the scope pattern chart in this lesson for a review of scope patterns, if necessary.

NAAO VEHICLE IGNITION SYSTEMS

INTRODUCTION

Vehicles produced by Ford in North America are known as North American Automotive Operations (NAAO) vehicles. There are two types of ignition systems currently used on **NAAO vehicles.**

- Distributor Ignition (DI)
- Electronic Ignition (EI)

DI System

A **distributor, distributor cap, distributor rotor**, coil wire and spark plug wires are used for secondary voltage distribution. Ignition timing advance and retard are done by the EEC system.

EI System

EI systems are distributorless. They contain multiple coils, known as **coil packs.** Secondary voltage is delivered directly from the coils to the spark plugs via spark plug wires. This ignition system also uses the EEC system to control spark timing.

There are two types of EI ignition systems:

- **Low Data Rate**
- **High Data Rate**

The DI and EI ignition systems will be covered individually in lessons 6 through 8.

IGNITION SYSTEM THEORY AND OPERATION

Lesson **1** Spark and Ignition

Lesson **2** Basic Ignition

Lesson **3** Ignition Requirements and Operating Modes

Lesson **4** Ignition Related Driveability Symptoms

Lesson **5** Basic Testing

NAAO

Lesson **6** **DI Ignition System**

Lesson **7** EI – Low Data Rate Ignition System

Lesson **8** EI – High Data Rate Ignition System

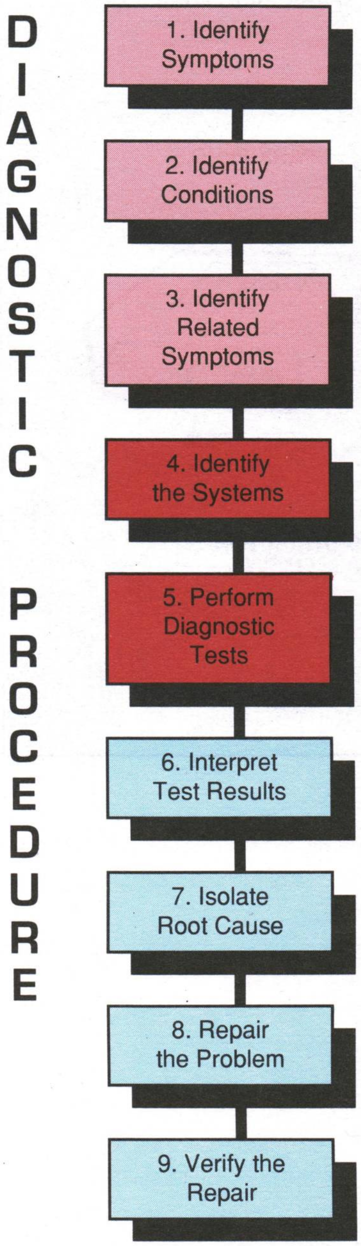
Lesson **9** EEC System Diagnosis

ASSOCIATION

Lesson **10** DI Electronically Controlled Timing

Lesson **11** DI Mechanically Controlled Timing

Lesson **12** Villager DI Ignition System



LESSON 6: DI IGNITION SYSTEM

Where does this lesson fit into the diagnostic procedure?

The information in this lesson relates to steps 4 and 5 of the diagnostic procedure. It covers the operation, diagnosis and testing of the DI ignition systems used on NAAO vehicles.

Objective(s):

The information in this lesson will enable you to:

- Identify and describe the operation of the ignition system components and describe their functions in operating as a system.
- Identify and describe ignition system diagnostic procedures and test equipment.

DI IGNITION SYSTEM

DESCRIPTION

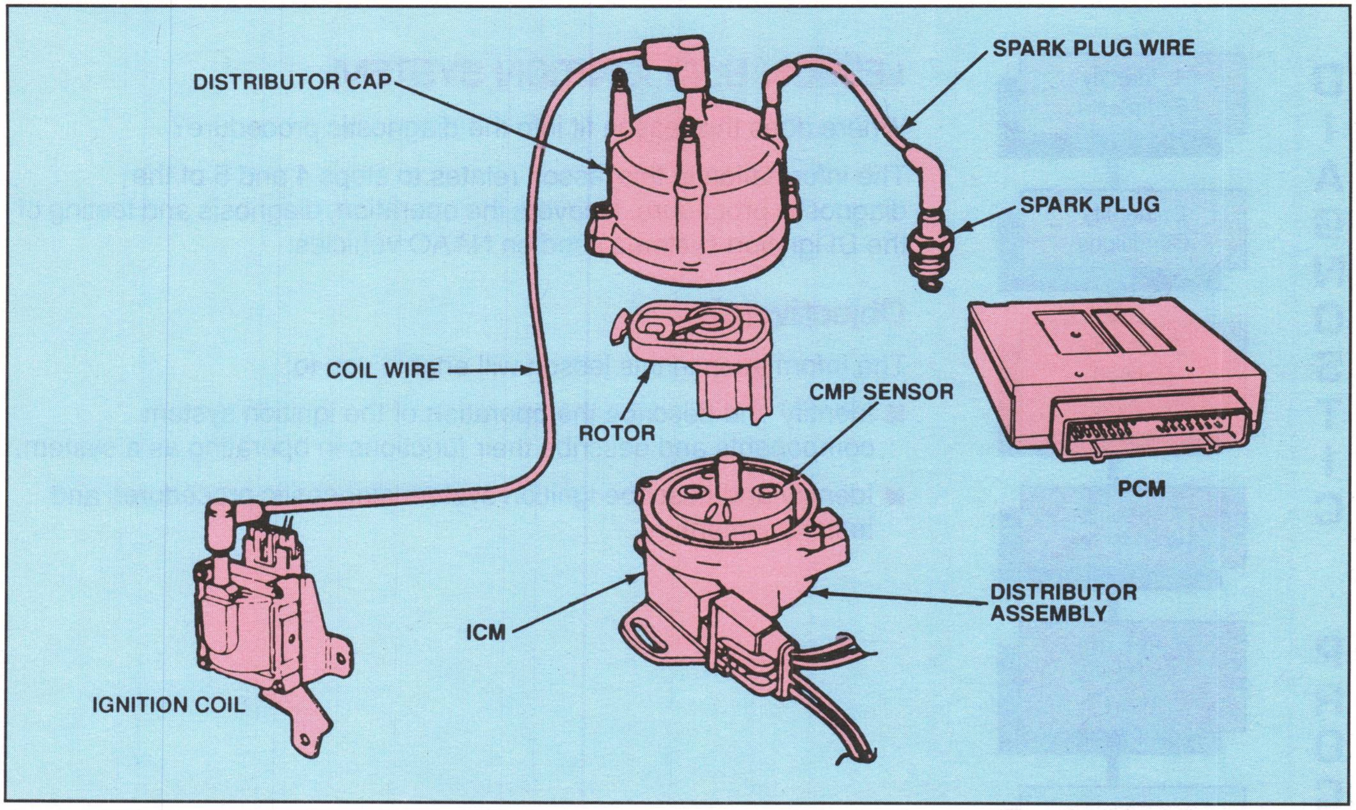


Figure 6-1 — DI primary control components

The components of the DI system include the following:

- Ignition coil
- Camshaft Position (CMP) sensor
- Ignition Control Module (ICM)
- Powertrain Control Module (PCM)
- Distributor
- Distributor cap and rotor
- Coil wire
- Spark plug wires
- Spark plugs

OPERATION

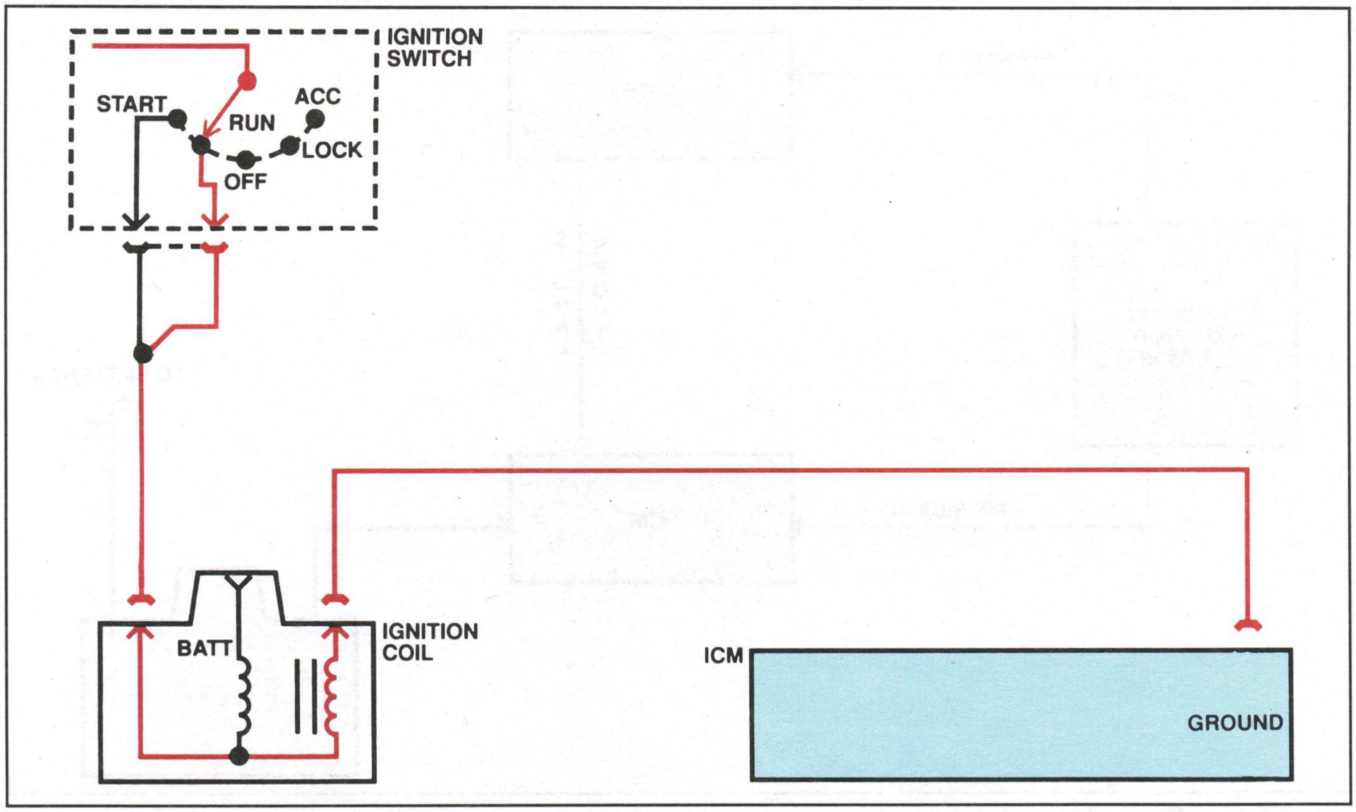


Figure 6-2 — Primary circuit schematic

Primary current flows through the ignition switch and coil primary winding. It grounds through the ICM. The ICM contains a transistor (solid state switch). The transistor opens and closes the path to ground.

The ICM uses two signals to control the opening and closing of the transistor:

- Profile Ignition Pick-up (PIP)
- Spark Output (SPOUT)

PIP Signal

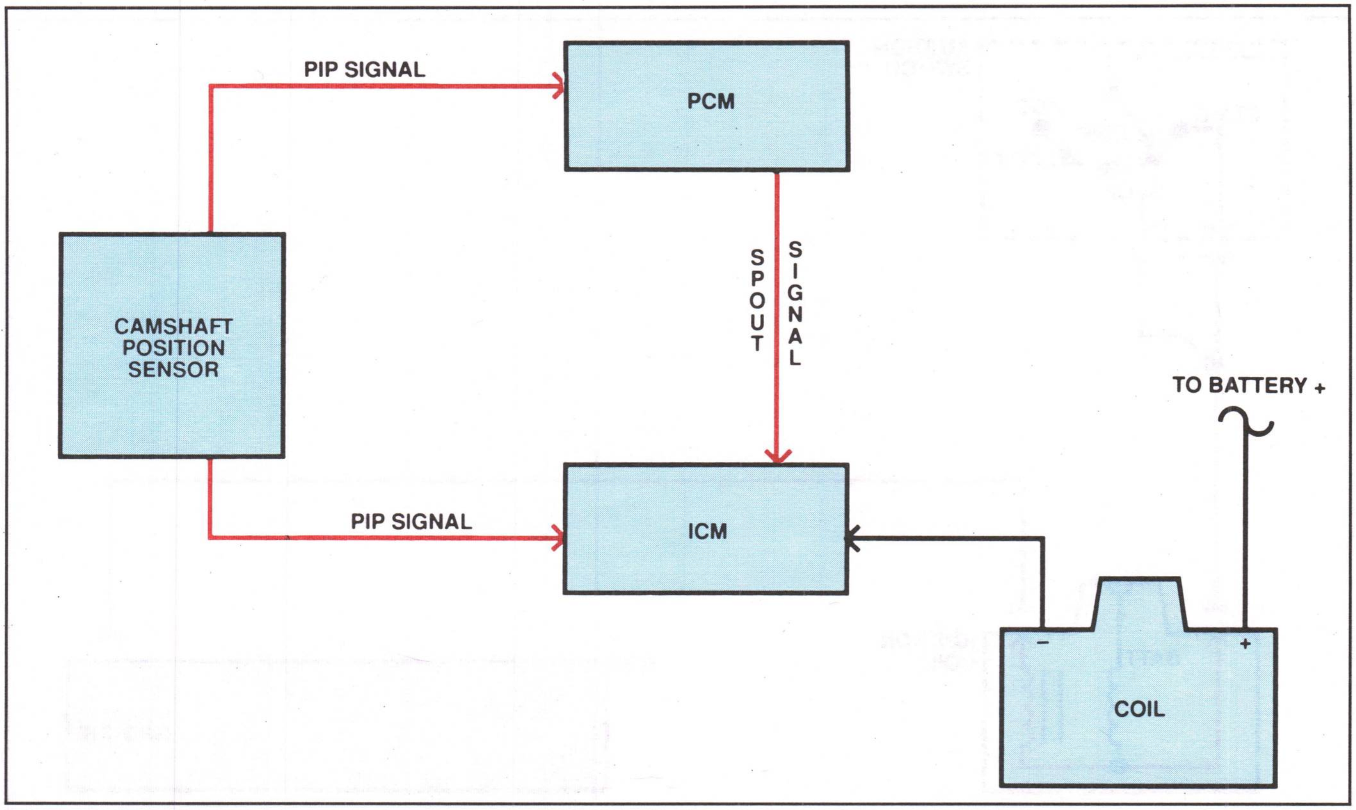


Figure 6-3 — PIP signal

When the distributor armature rotates, the **Camshaft Position (CMP)** sensor provides a **digital** signal to the ICM and PCM. The CMP sensor is a Hall effect device. The **signal** produced by the CMP is called the **Profile Ignition Pick-up (PIP)** signal. The PIP signal indicates crankshaft position and engine speed. The PCM uses the PIP signal along with other input data to determine the correct spark timing. The PCM sends a **Spark Output (SPOUT)** signal to the ICM which tells the ICM when to fire the coil.

SPOUT Signal

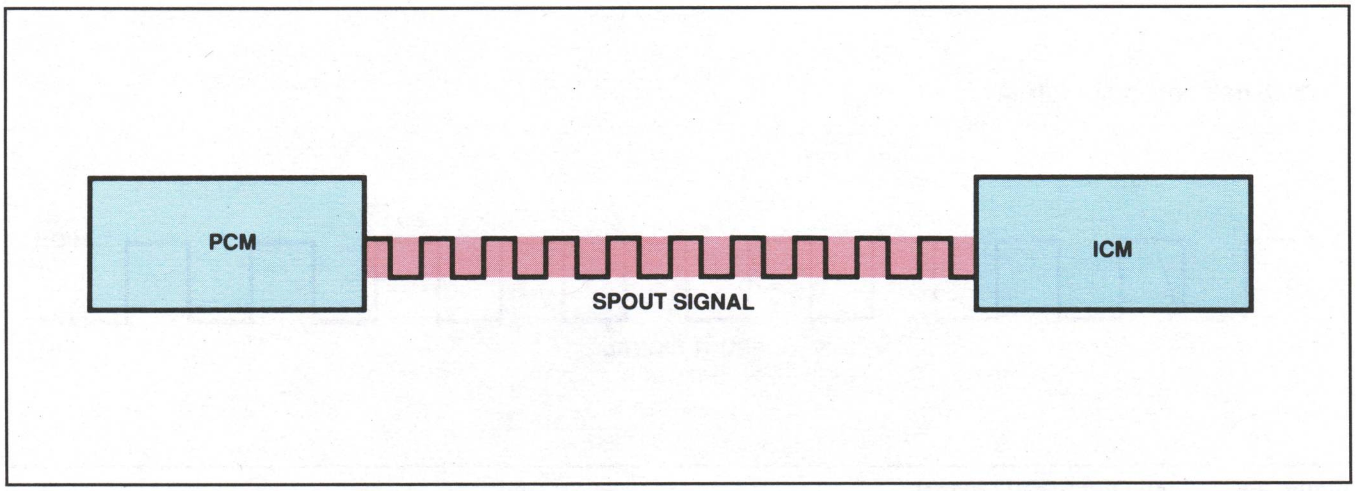


Figure 6-4 — SPOUT signal

The SPOUT signal from the PCM is a digital signal. The SPOUT signal directs the ICM when to open the coil's primary ground circuit.

IDM and Tachometer Signal

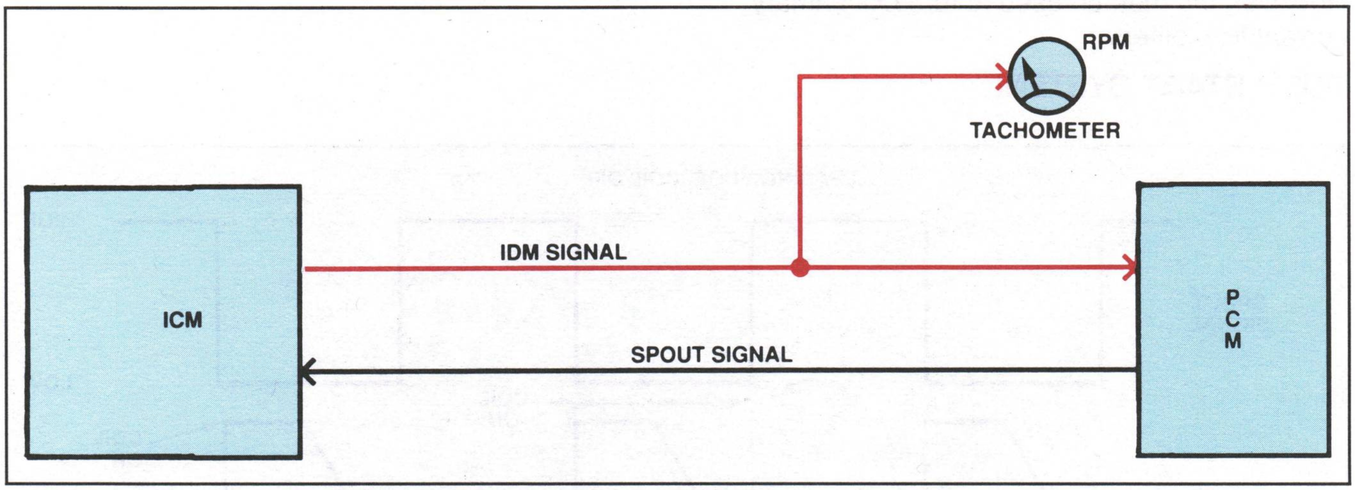


Figure 6-5 — IDM signal

When the primary ground circuit is opened, a high voltage spike occurs in the primary circuit. This voltage spike is sent to the PCM as an **Ignition Diagnostic Monitor (IDM)** signal. This signal is also provides a **tachometer** signal.

Ignition Dwell

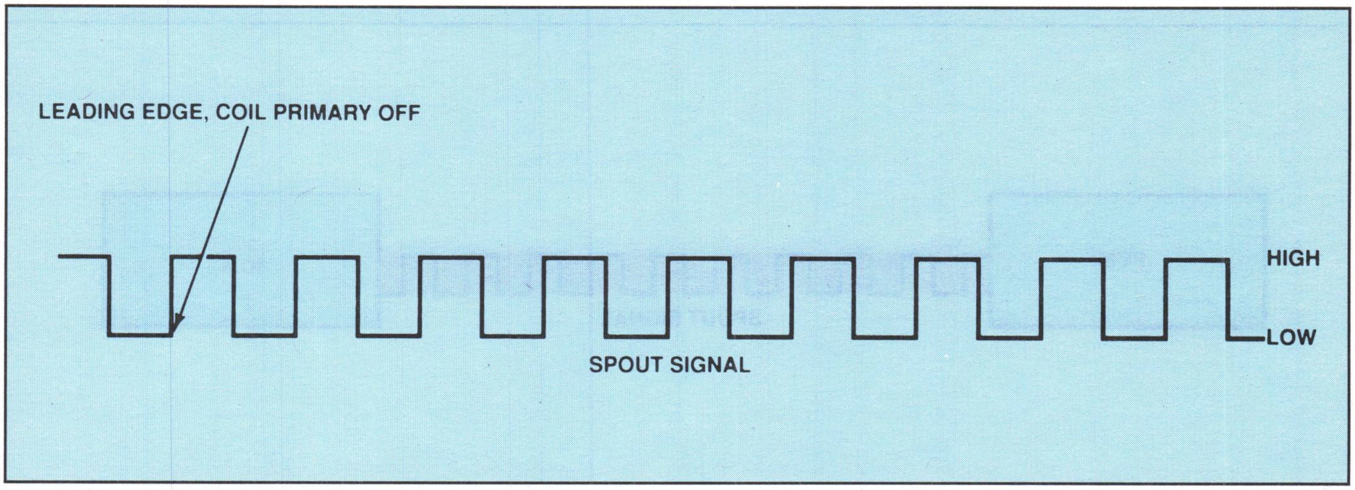


Figure 6-6 — Push start SPOUT signal

There are two systems used to control dwell. One is called the push start system and the other is called **Computer Controlled Dwell (CCD)**. The major difference is with ICM circuitry. On both systems, the ICM uses the SPOUT signal to turn OFF primary current flow and fire the spark plug. However, the method used to turn ON primary current flow differs.

PUSH START SYSTEM

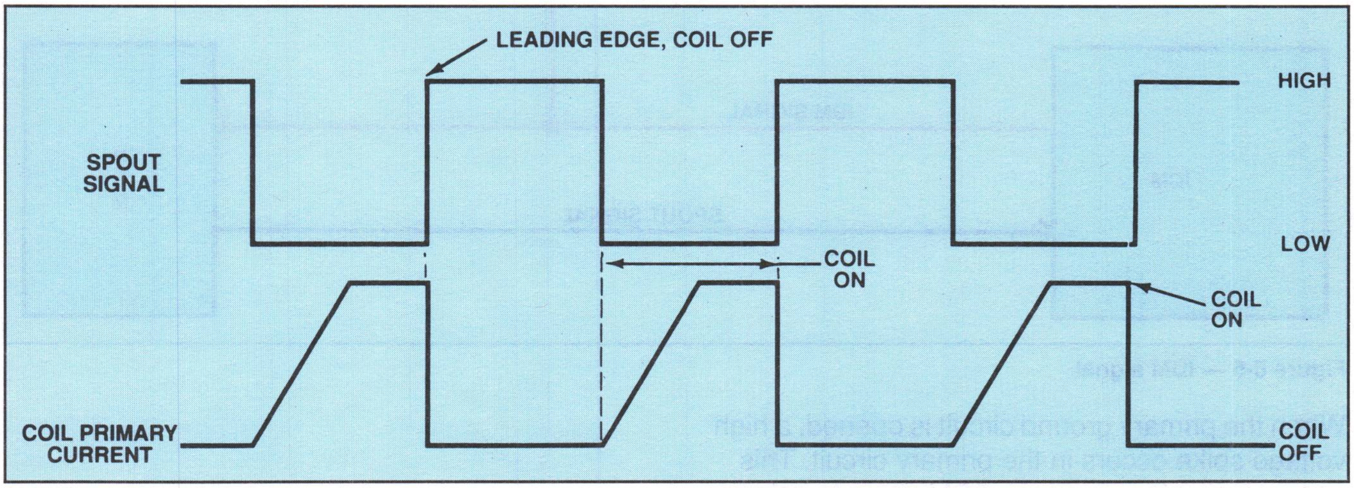


Figure 6-7 — Push start coil control

The ICM uses the rising edge of the SPOUT signal to turn OFF the coil primary current and fire the spark plug. The ICM ignores the falling, or trailing, edge of the SPOUT signal. The coil ON time is determined by the ICM.

When the system is cranking, the Push Start system provides longer dwell (coil ON time) than when the engine is running.

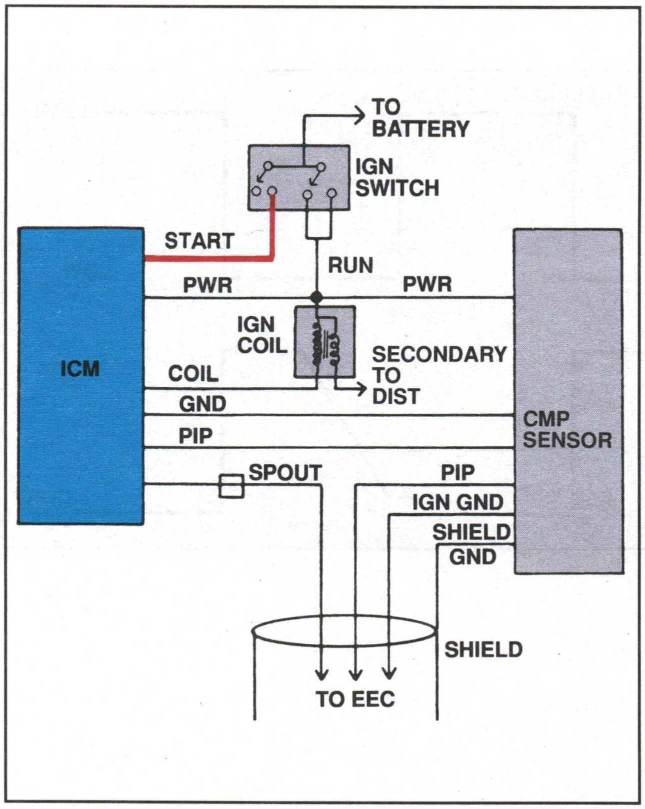


Figure 6-8 — Push start circuits

The push start ICM has a separate START circuit. The START circuit supplies the ICM with voltage during engine cranking. This informs the ICM that the engine is in the cranking mode.

CCD SYSTEM

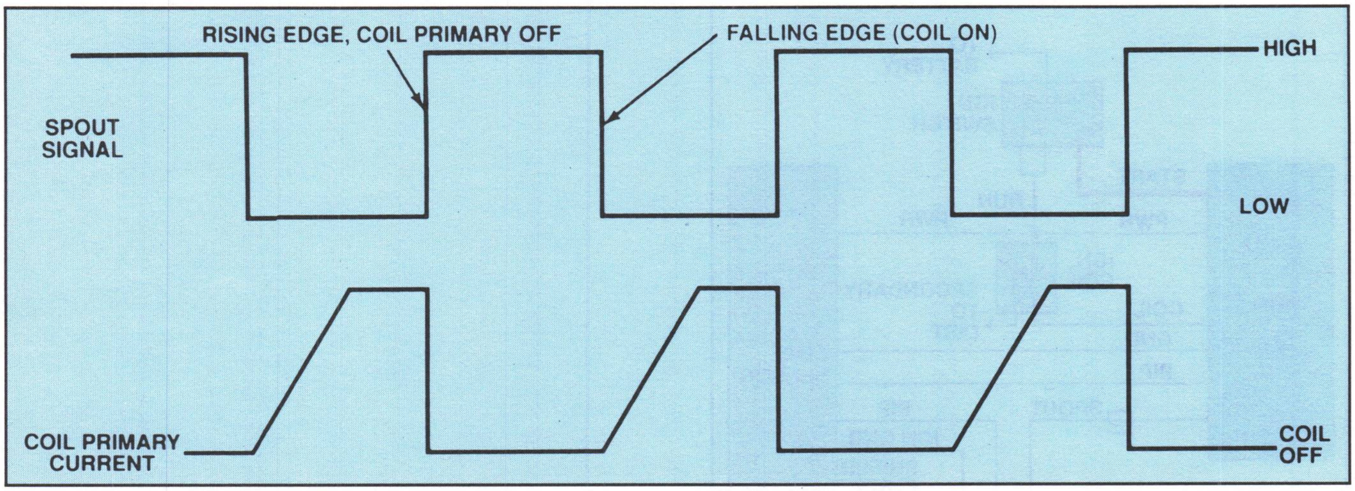


Figure 6-9 — CCD coil control

On CCD systems the SPOUT signal has complete control of dwell.

The ICM uses the rising edge of the SPOUT signal to turn the coil OFF and the falling edge of the SPOUT signal to turn the coil ON. Therefore, the dwell is entirely controlled by the SPOUT signal from the PCM. If the SPOUT circuit is open, the ICM will use the PIP signal to fire the coil. This results in fixed spark timing and dwell.

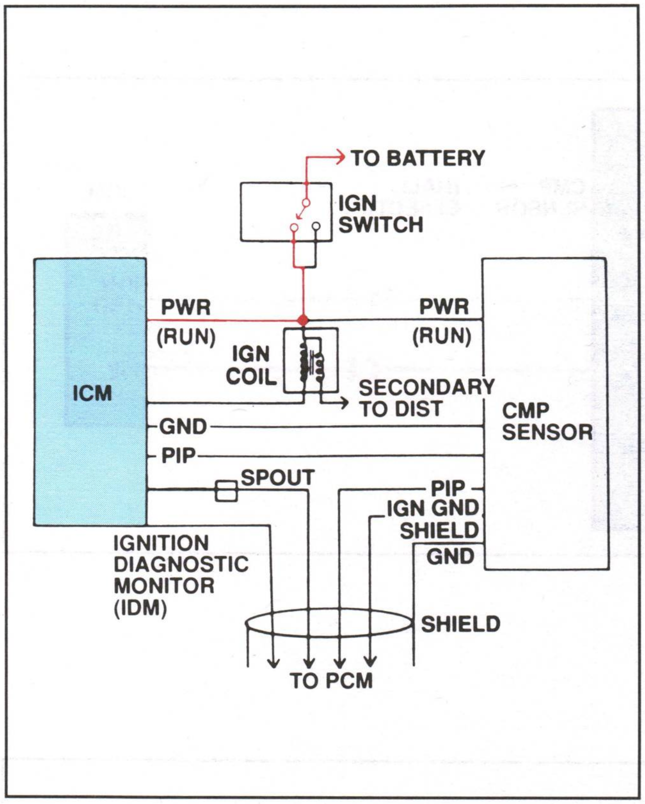


Figure 6-10 — CCD circuits

In the CCD system, the ICM has only the RUN circuit. The RUN circuit supplies the ICM with voltage during cranking and when the engine is running.

DI DIAGNOSIS AND TESTING

This part of the lesson contains information on diagnosing and testing the following DI components and circuits:

- **Camshaft Position (CMP)** sensor
- Ignition Control Module (ICM)
- SPOUT circuit
- Ignition Diagnostic Monitor (IDM) circuit

There are several DI system configurations. The ICMs of each configuration are different and cannot be interchanged. Also some circuitry is different between the configurations. For example, the IDM circuit on push start systems contains an in-line 22 KΩ resistor. CCD systems do not have an in-line resistor. Always refer to the "Ignition System" section in the PCED manual when diagnosing and servicing DI ignition systems.

CMP Sensor

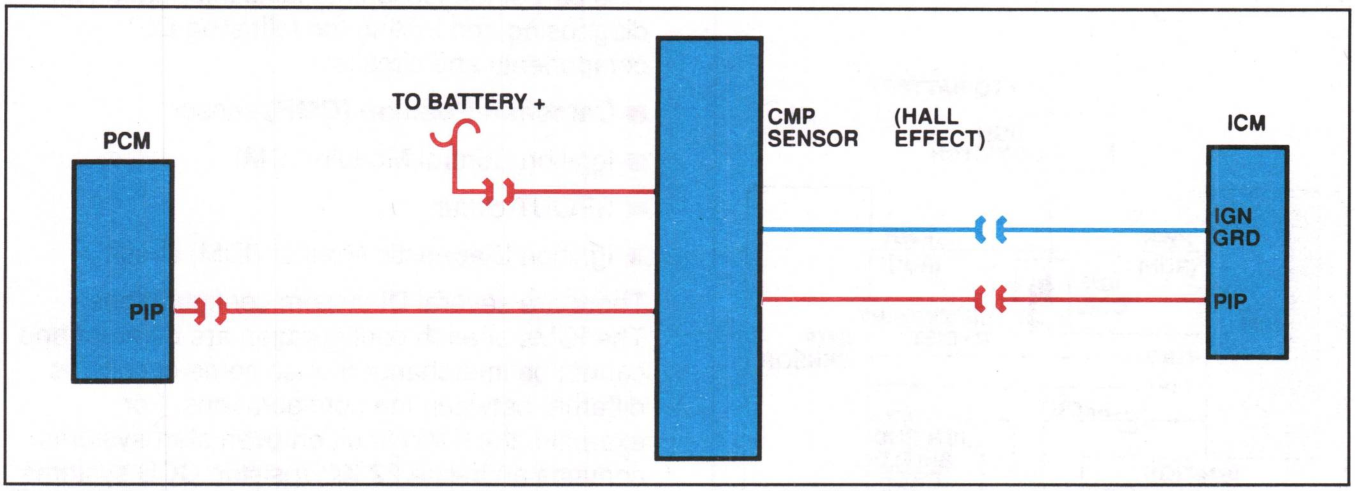


Figure 6-11 — Signal distribution

The CMP sensor provides a digital PIP signal to the ICM and PCM. The CMP sensor has power supply, ground and signal circuits.

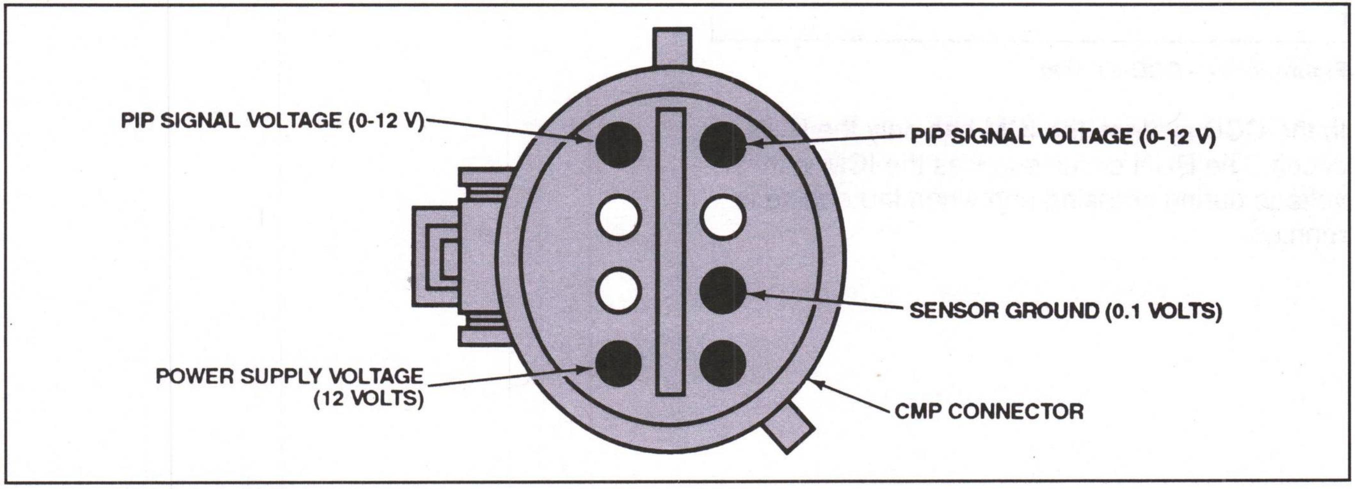

PIP SIGNAL VOLTAGE (0-12 V)
PIP SIGNAL VOLTAGE (0-12 V)
SENSOR GROUND (0.1 VOLTS)
POWER SUPPLY VOLTAGE (12 VOLTS)
CMP CONNECTOR

Figure 6-12 — CMP testing

With the ignition switch in the ON position, supply voltage should be within one volt of battery voltage. Voltage at the sensor ground should be very close to zero volts. Voltage in the signal circuit will vary between 0V and 12V when the engine is cranking or running.

The PIP signal can be monitored with a DVOM set on a DC 20 volt scale. Because of the rapid switching between 0V and 12V, the voltage reading on the display will be approximately 6.0 volts.

Follow the procedure in the PCED manual for testing.

ICM

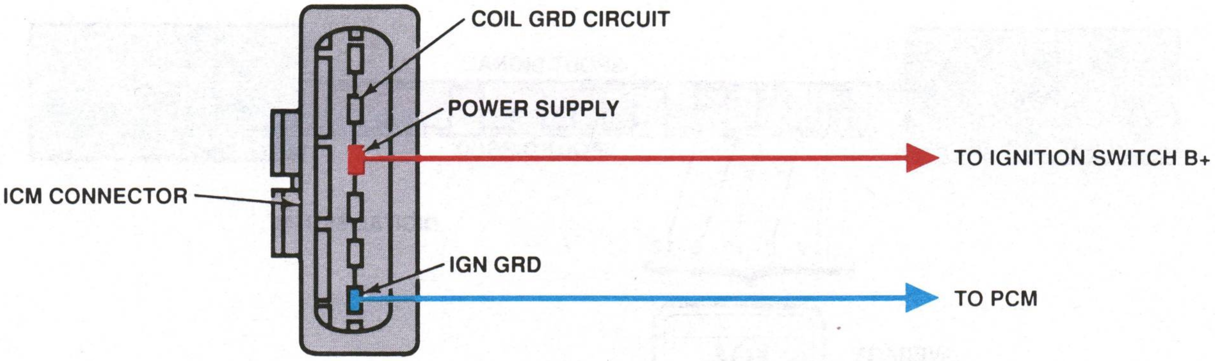


Figure 6-13 — ICM power and ground

The ICM is the component that supplies a ground path for primary current flow. In order to operate properly, it needs to have the following:

- Supply voltage for itself
- Ground – for itself and primary current flow.
- Ignition signal circuit – to open the primary circuit and collapse the coil's primary field.

With the key ON, supply voltage should be within one (1) volt of battery voltage.

Ground for the ICM and primary current flow may be through a separate ground wire or the housing of the ICM. Check the ground circuit with a voltmeter. ICM ground should not exceed 0.2 volt drop with the ignition switch ON.

Follow the procedure in the PCED manual for testing.

SPOUT Circuit

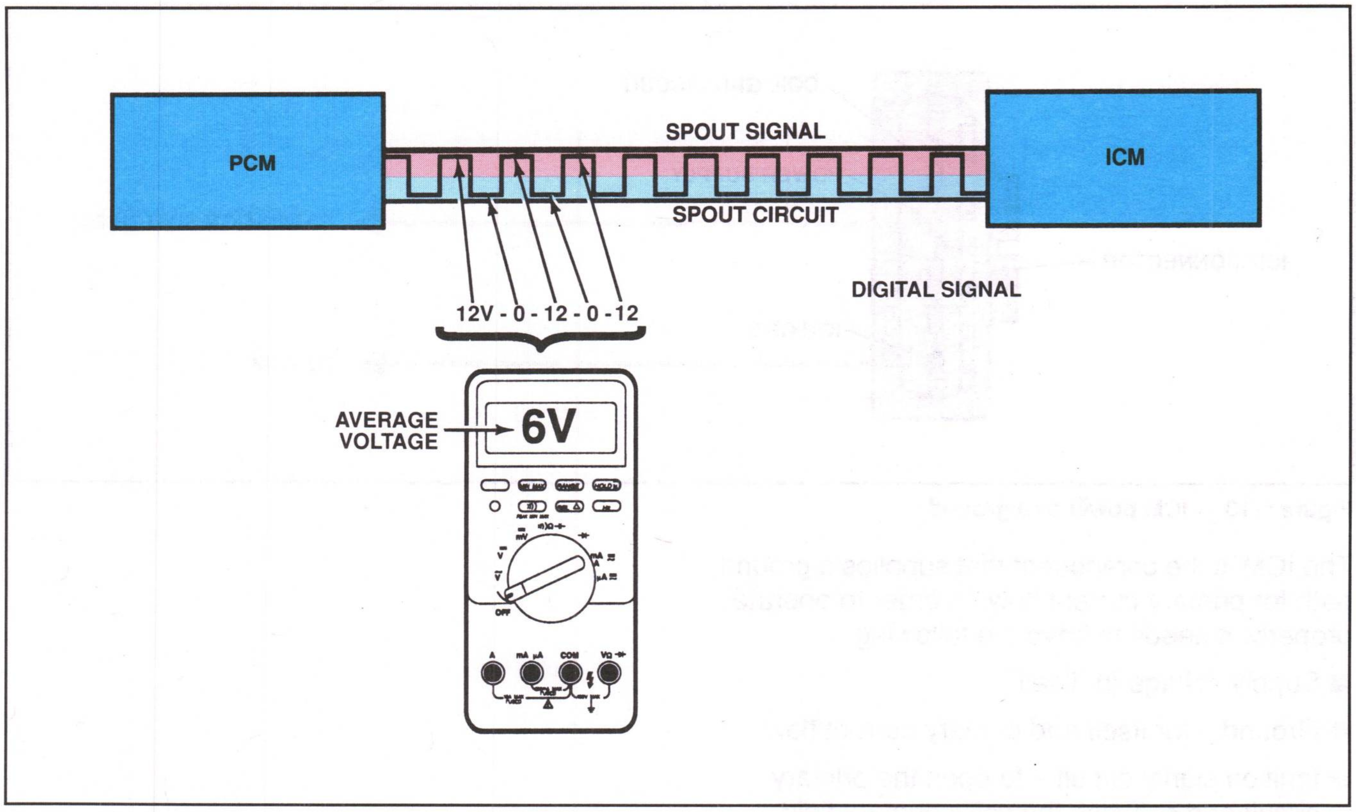


Figure 6-14 — SPOUT circuit test

The SPOUT circuit carries a digital voltage signal from the PCM to the ICM. The voltage varies between 0V and 12V. A DVOM can be used to confirm that a SPOUT signal exists. It will register approximately 6 volts, which is the average voltage as the signal fluctuates between low (0V) and high (12V).

Follow the procedure in the PCED manual for testing.

IDM Circuit

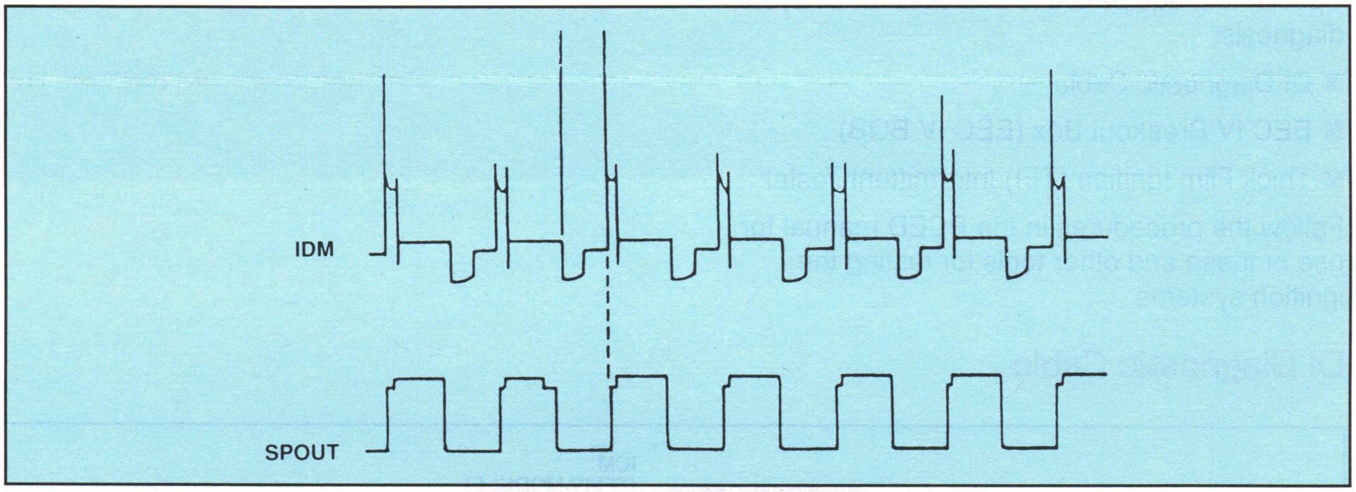


Figure 6-15 — IDM signal – inverted from SPOUT

The IDM circuit is a digital signal. The IDM signal can be detected using the BOB and a DVOM.

Follow the procedure in the PCED manual for testing.

NOTE: The PIP, SPOUT and IDM signals provide the ICM and PCM with essential data. If these signals are distorted or interfered with, in any way, driveability concerns could result. For this reason these circuits are well protected and typically shielded. Be sure all shields are in place and grounded. However, do not install a ground circuit to a shield that is already grounded. Only one ground circuit should be connected to a protective shield.

DI SPECIALTY DIAGNOSTICS

Special test equipment is available for DI system diagnosis:

- DI Diagnostic Cable
- EEC IV Breakout Box (EEC IV BOB)
- Thick Film Ignition (TFI) Intermittent Tester

Follow the procedures in the PCED manual for use of these and other tools for testing the ignition systems

DI Diagnostic Cable

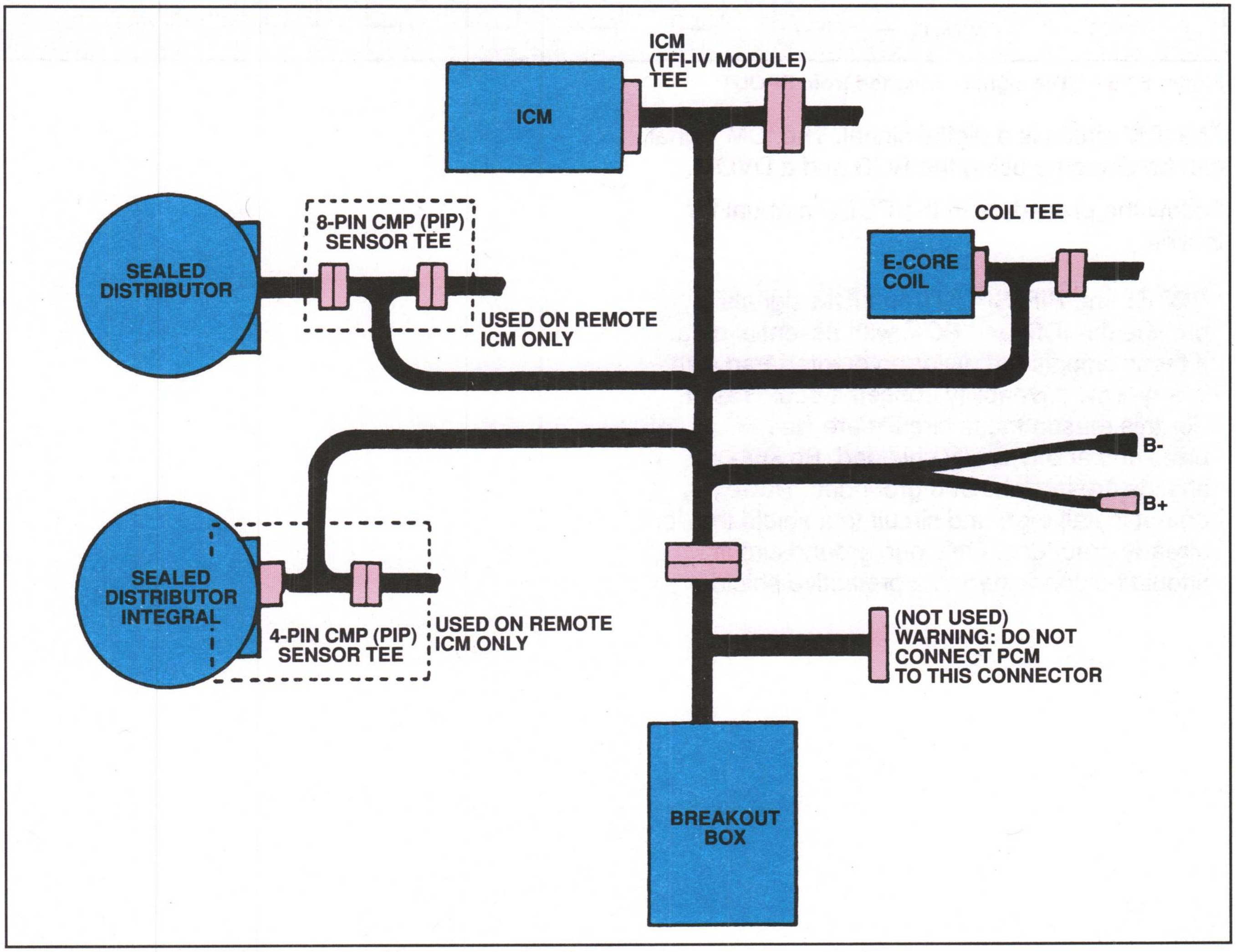

ICM
ICM (TFI-IV MODULE) TEE
8-PIN CMP (PIP) SENSOR TEE
SEALED DISTRIBUTOR
USED ON REMOTE ICM ONLY
COIL TEE
E-CORE COIL
B-
B+
SEALED DISTRIBUTOR INTEGRAL
4-PIN CMP (PIP) SENSOR TEE
USED ON REMOTE ICM ONLY
(NOT USED) WARNING: DO NOT CONNECT PCM TO THIS CONNECTOR
BREAKOUT BOX

Figure 6-16 — DI diagnostic cable

The DI Diagnostic Cable has leads that connect to the DI system and to the **EEC IV BOB**. This setup allows you to access DI circuits through the BOB pins.

EEC IV BOB

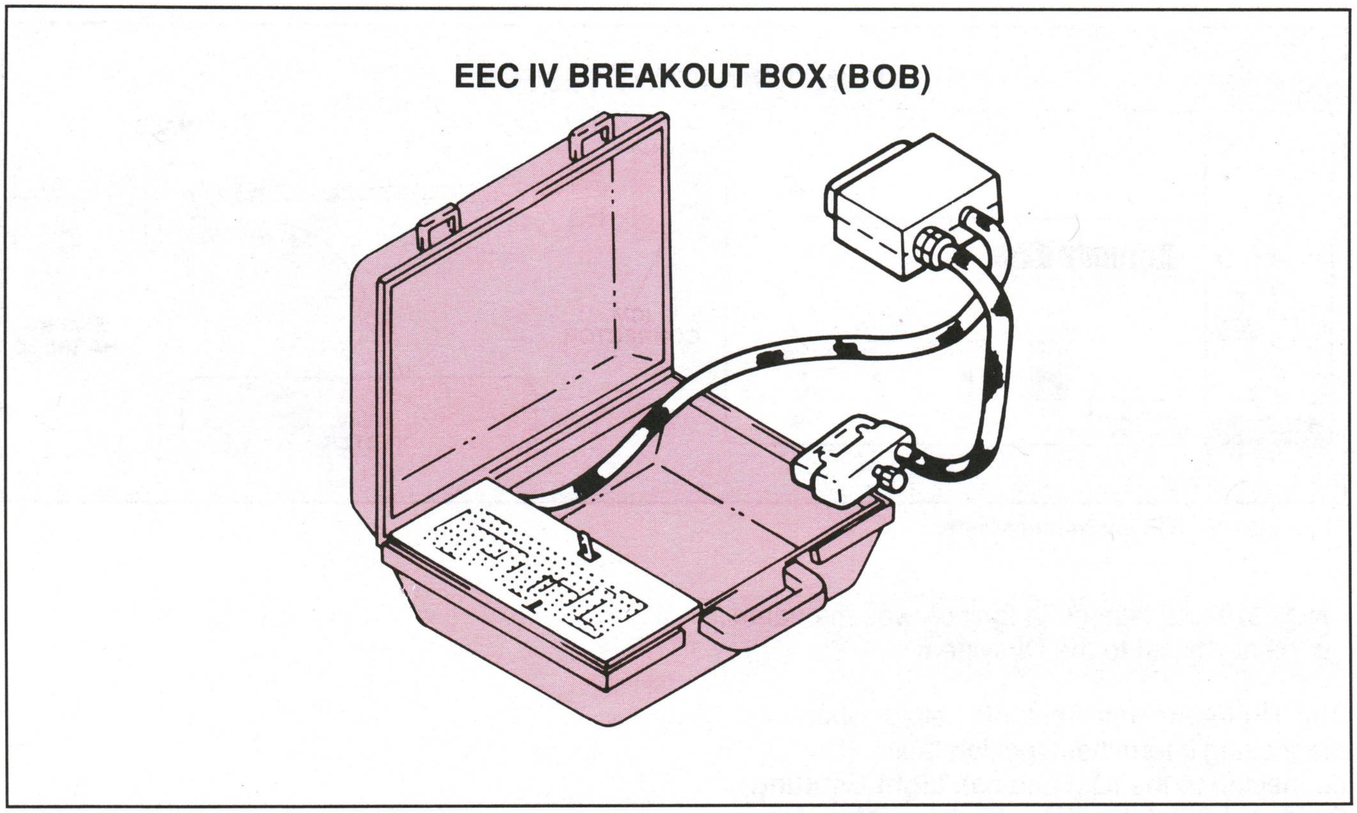

EEC IV BREAKOUT BOX (BOB)

Figure 6-17 — EEC IV BOB

The EEC IV Breakout Box (BOB) is a 60 pin circuit board. When connected to the DI system, through the DI Diagnostic Cable, you can check circuit resistance and system voltages without probing harnesses and connectors.

Refer to the "Ignition System Diagnostic Procedures" section in the PCED manual for diagnostic routines with the DI Diagnostic Cable and BOB.

TFI Intermittent Tester

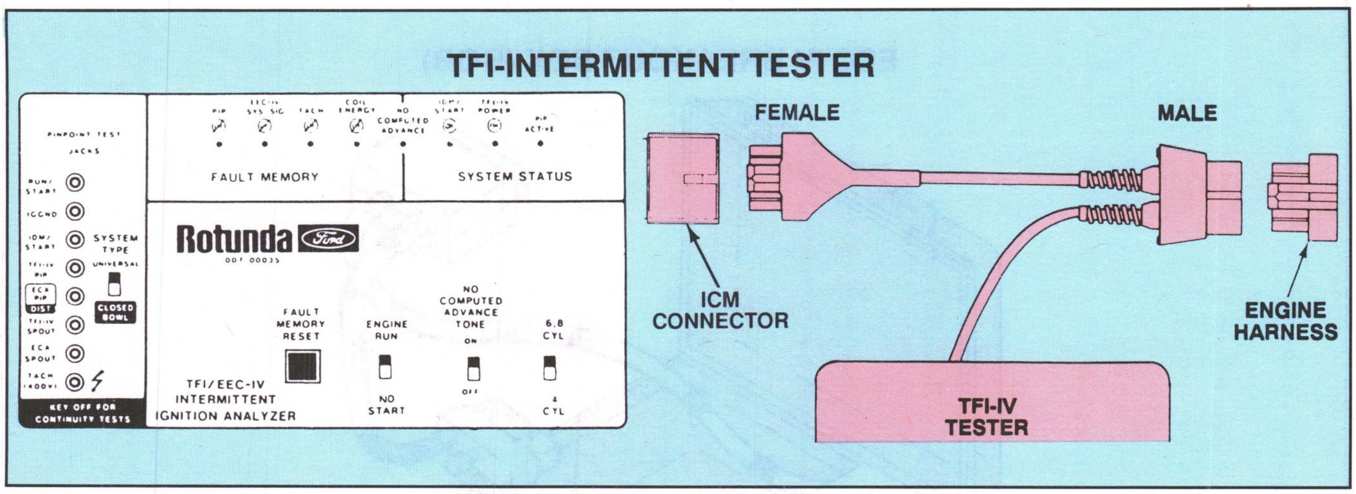


Figure 6-18 — TFI intermittent tester

NOTE: Thick Film (TFI) Ignition was the name originally given to the DI system.

The TFI Intermittent Tester is helpful when diagnosing intermittent ignition faults. It is connected to the ICM and has **Light Emitting Diodes (LEDs)** that light up during different conditions.

NOTE: The TFI Intermittent Tester is not compatible with CCD DI systems unless it has been updated. When using the tester, refer to the operating instructions supplied with the tester.

This is the end of Lesson 6. Now view Lesson 6 on the video tape, and answer the Progress Check questions.

LESSON 6 – PROGRESS CHECK QUESTIONS

The following questions are based on the information contained in Lesson 6. Choose the **ONE** best correct answer. The answers are provided on the following page. Review any questions missed before proceeding to the next lesson.

1. The PIP signal:
   - A. tells the distributor which plug wire to fire.
   - B. provides engine speed and position information which is used by the ICM and PCM.
   - C. provides the Hall effect sensor with engine speed and position information.
   - D. is sent to the ICM by the PCM.

2. Technician A says a SPOUT signal is used by the PCM to fire the coil. Technician B says the PCM sends a digital signal to the ICM which controls spark timing. Who is right?
   - A. Technician A
   - B. Technician B
   - C. Both A and B
   - D. Neither A nor B

3. A _________ signal is sent to the ICM from the PCM to control spark timing.
   - A. Dwell
   - B. PIP
   - C. CID
   - D. SPOUT

4. What signal is an inverted image of the SPOUT signal?
   - A. PIP
   - B. ICM
   - C. PCM
   - D. IDM

DI IGNITION SYSTEM

LESSON 6 – PROGRESS CHECK ANSWERS

1. The PIP signal:

   A. tells the distributor which plug wire to fire.
   [✓ B.] provides engine speed and position information which is used by the ICM and PCM.
   C. provides the Hall effect sensor with engine speed and position information.
   D. is sent to the ICM by the PCM.

   The Hall effect sensor produces a PIP signal. The signal is sent to the ICM and PCM and is used to determine when the coil should be fired.

2. Technician A says the SPOUT signal is used by the PCM to fire the coil. Technician B says the PCM sends a digital signal to the ICM which controls spark timing. Who is correct?

   A. Technician A
   [✓ B.] Technician B
   C. Both A and B
   D. Neither A nor B

   The PCM sends the SPOUT signal to the ICM to control timing.

3. A _________ signal is sent to the ICM from the PCM to control spark timing.

   A. Dwell
   B. PIP
   C. CID
   [✓ D.] SPOUT

   The SPOUT signal is sent by the PCM to control timing.

4. What signal is an inverted image of the SPOUT signal?

   A. PIP
   B. ICM
   C. PCM
   [✓ D.] IDM

   The IDM signal is an inverted image of the SPOUT signal and supplies a **tach** signal.

LESSON 6 – PROGRESS CHECK QUESTIONS (CONT'D)

5. Technician A says coil ON time is controlled by the SPOUT signal on a push start system. Technician B says the trailing edge of the SPOUT signal is used to determine when to turn the coil ON in a push start system. Who is correct?

   A. Technician A

   B. Technician B

   C. Both A and B

   D. Neither A nor B

6. Technician A says that a typical PIP signal voltage reading is 6.0 volts. Technician B says that the typical DVOM voltage reading of a PIP signal is the average of the amplitude of the Square wave signal. Who is correct?

   A. Technician A

   B. Technician B

   C. Both A and B

   D. Neither A nor B

7. Technician A says that the DI diagnostic cable should only be used to diagnose an intermittent concern. Technician B says that the diagnostic routines for the DI diagnostic cable can be found in the shop manual and EVTM. Who is correct?

   A. Technician A

   B. Technician B

   C. Both A and B

   D. Neither A nor B

LESSON 6 – PROGRESS CHECK ANSWERS (CONT'D)

5. Technician A says coil ON time is controlled by the SPOUT signal on a push start system. Technician B says the trailing edge of the SPOUT signal is used to determine when to turn the coil ON in a push start system. Who is correct?

   A. Technician A

   B. Technician B

   C. Both A and B

   [✓ D.] Neither A nor B

   The CCD system uses the SPOUT signal to control coil ON and OFF time. The push start system only uses the rising edge of the SPOUT signal to fire the coil. Dwell is determined solely by the ICM. The trailing edge of the SPOUT signal is ignored.

6. Technician A says that a typical PIP signal voltage reading is 6.0 volts. Technician B says that the typical DVOM voltage reading of a PIP signal is the average of the amplitude of the square wave signal. Who is correct?

   A. Technician A

   B. Technician B

   [✓ C.] Both A and B

   D. Neither A nor B

   The reading obtained with a DVOM is the average of the amplitude from the square wave PIP signal. That average is typically 6.0 volts.

7. Technician A says that the DI diagnostic cable should only be used to diagnose an intermittent concern. Technician B says that the diagnostic routines for the DI diagnostic cable can be found in the shop manual and EVTM. Who is correct?

   A. Technician A

   B. Technician B

   C. Both A and B

   [✓ D.] Neither A nor B

   The DI diagnostic cable can be used to diagnose all DI related concerns, not just intermittent malfunctions. The PCED manual contains diagnostic instructions and routines.

IGNITION SYSTEM THEORY AND OPERATION

Lesson 1 Spark and Ignition

Lesson 2 Basic Ignition

Lesson 3 Ignition Requirements and Operating Modes

Lesson 4 Ignition Related Driveability Symptoms

Lesson 5 Basic Testing

NAAO

Lesson 6 DI Ignition System

Lesson 7 EI – Low Data Rate Ignition System

Lesson 8 EI – High Data Rate Ignition System

Lesson 9 EEC System Diagnosis

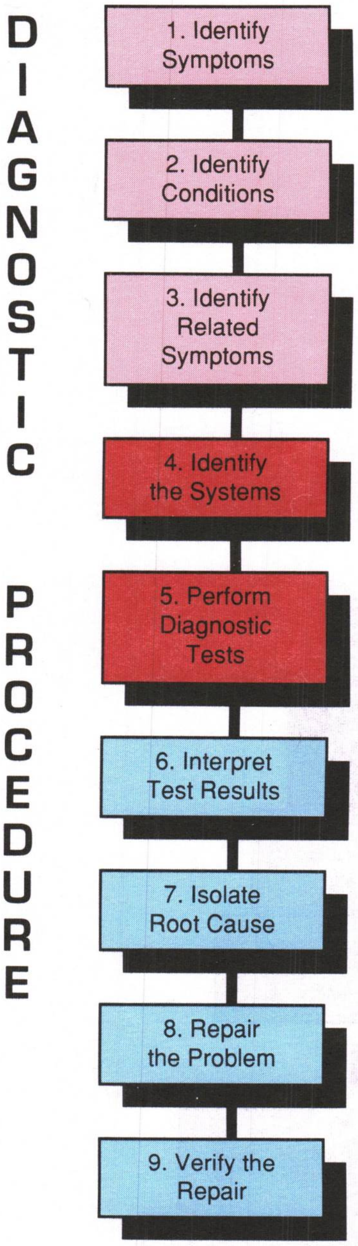
ASSOCIATION

Lesson 10 DI Electronically Controlled Timing

Lesson 11 DI Mechanically Controlled Timing

Lesson 12 Villager DI Ignition System

EI — LOW DATA RATE IGNITION SYSTEM



LESSON 7: EI LOW DATA RATE IGNITION SYSTEM

Where does this lesson fit into the diagnostic procedure?

The information in this lesson relates to steps 4 and 5 of the diagnostic procedure. It covers the operation, diagnosis and testing of the EI — low data rate ignition system.

Objective(s):

The information in this lesson will enable you to:

- Identify and describe the operation of the ignition system components and describe their functions in operating as a system.
- Idneify and describe ignition system diagnostic procedures and test equipment.

EI — LOW DATA RATE IGNITION SYSTEM

DESCRIPTION

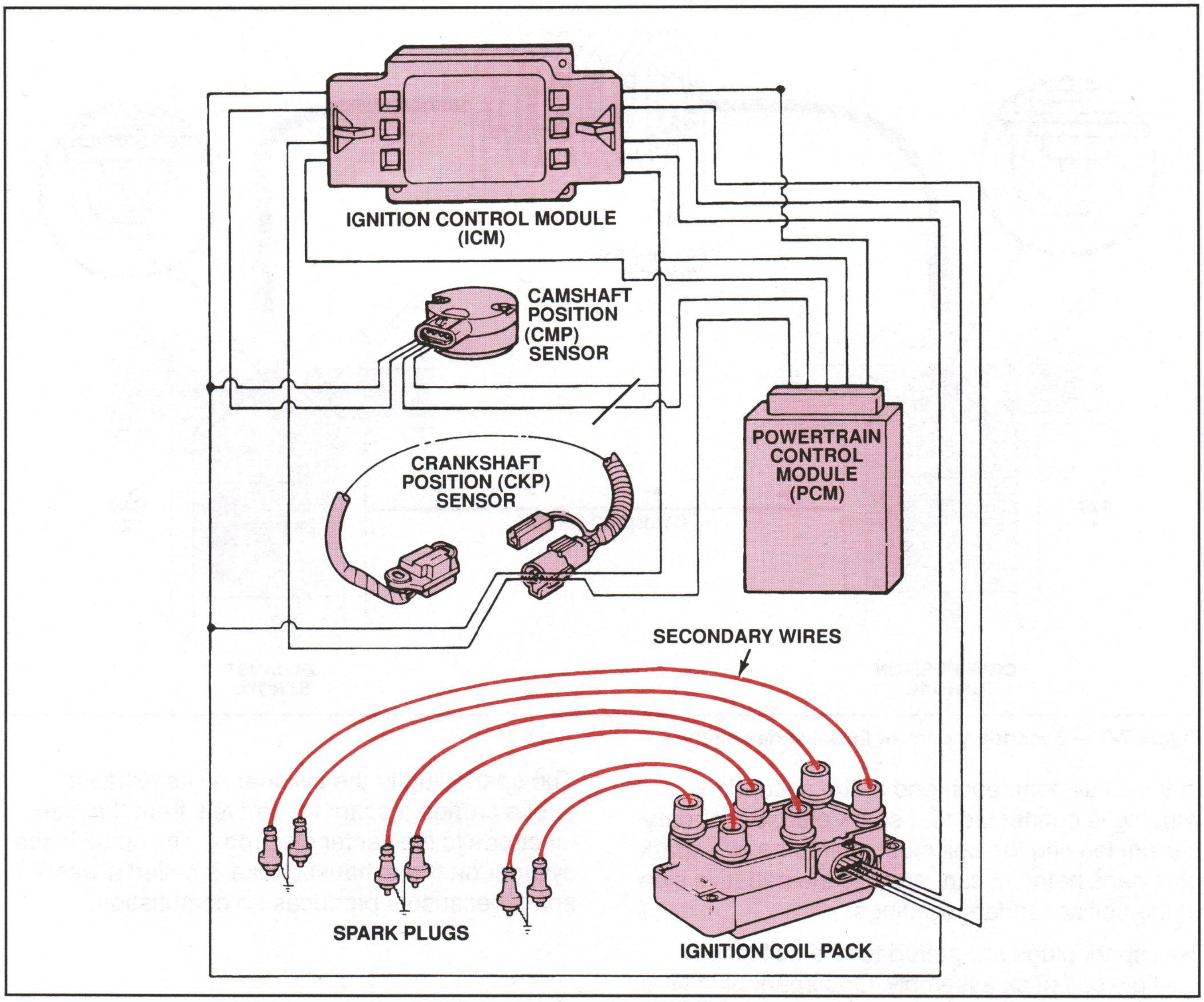

IGNITION CONTROL MODULE (ICM)
CAMSHAFT POSITION (CMP) SENSOR
CRANKSHAFT POSITION (CKP) SENSOR
POWERTRAIN CONTROL MODULE (PCM)
SECONDARY WIRES
SPARK PLUGS
IGNITION COIL PACK

Figure 7-1 — EI – low data rate ignition system components

The EI – low data rate system consists of:

- Ignition Control Module (ICM)
- Powertrain Control Module (PCM)
- Spark plugs
- Secondary wires
- Camshaft Position (CMP) sensor
- Crankshaft Position (CKP) sensor
- Coil pack

The most important feature of this system is that secondary voltage is delivered to each spark plug without the use of a distributor.

Coil Secondary Circuit

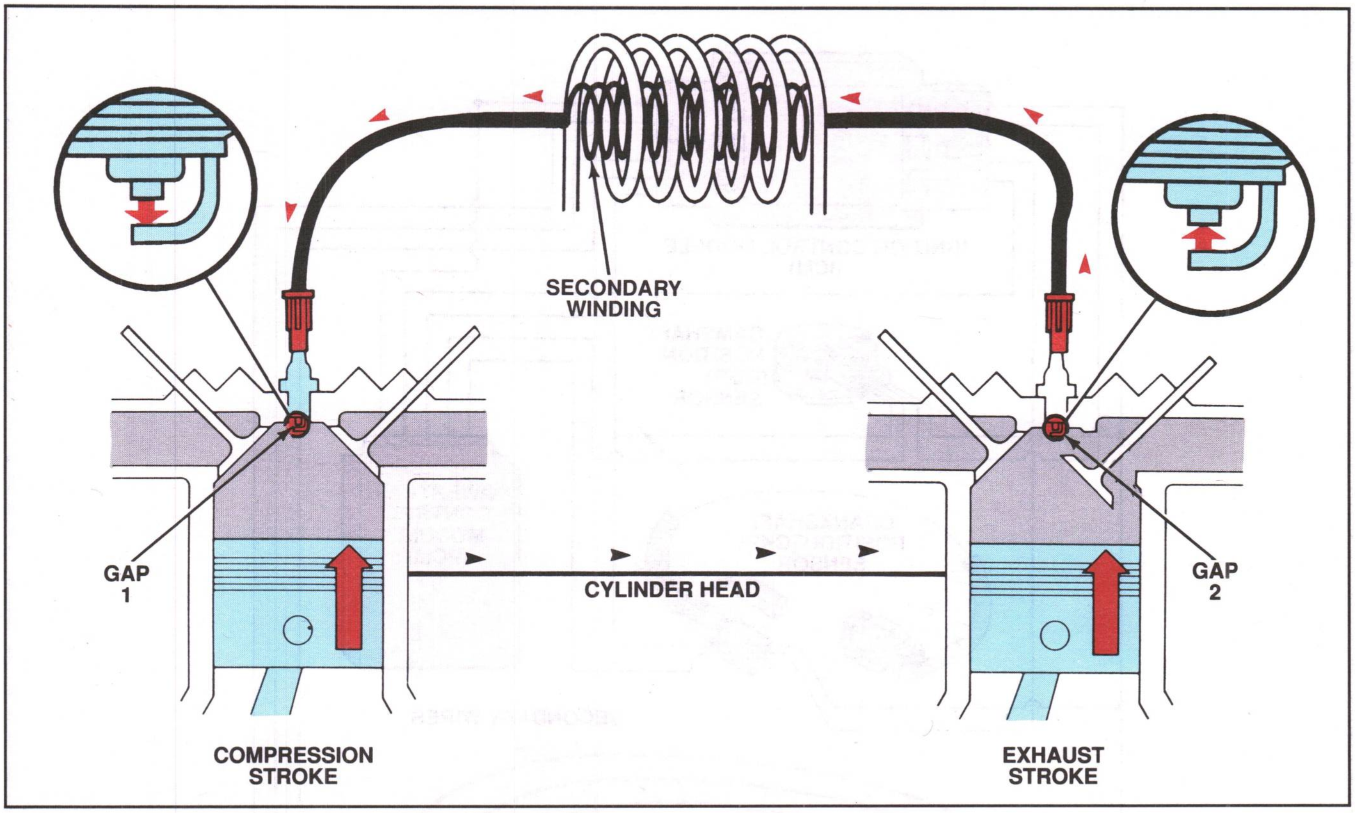


Figure 7-2 — Secondary current flow – series circuit

In the EI system, each end of the secondary winding is connected to a spark plug. Secondary current leaving the coil must overcome two spark plug gaps before it can return to the negative side of the coil secondary windings.

Two spark plugs are paired to one coil in the multiple coil pack assembly. One spark plug fires on the compression stroke of a cylinder while the other spark plug fires on the exhaust stroke of another cylinder.

The spark plug in the cylinder on its exhaust stroke carries a spark that travels from the side electrode to the center electrode. The spark in the cylinder on the exhaust stroke is called a waste spark because it produces no combustion.

Cylinder Pairs

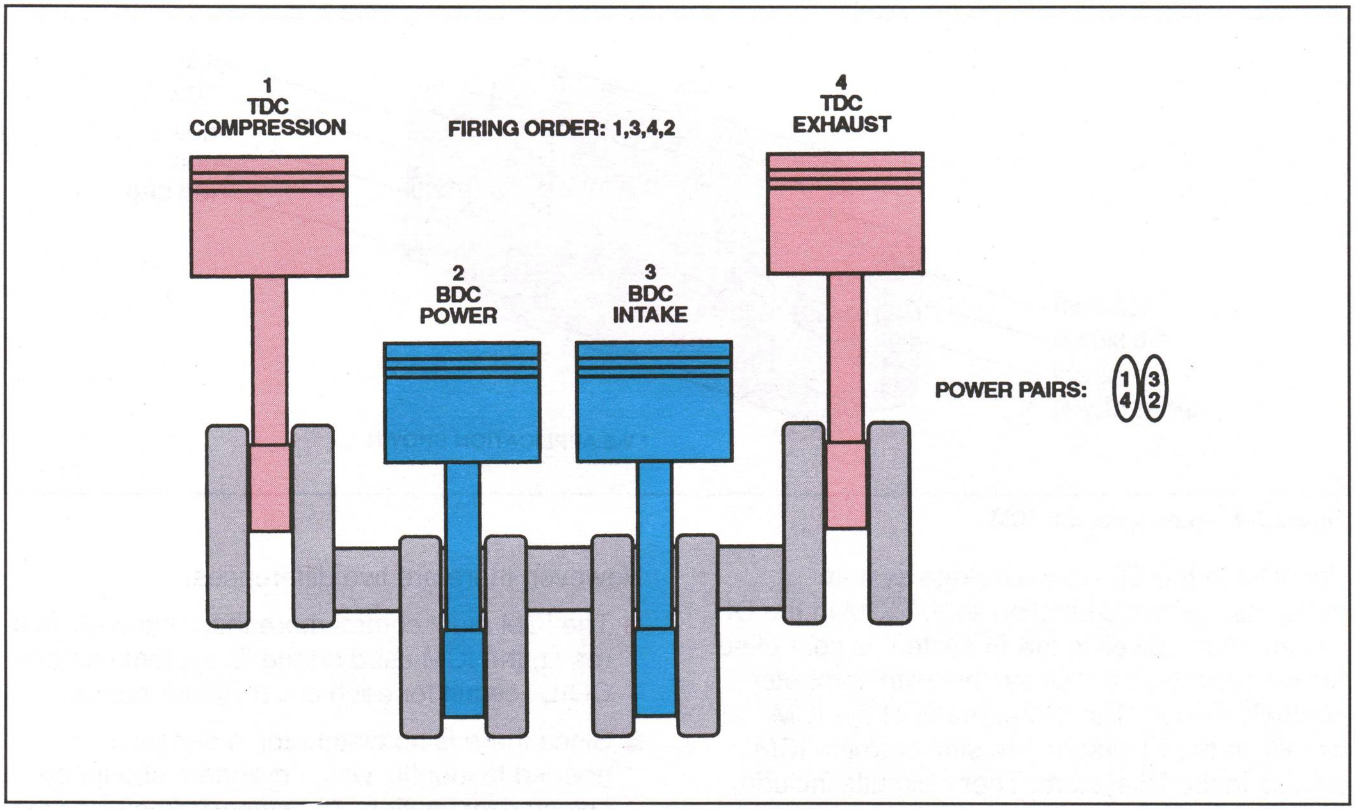


Figure 7-3 — Cylinder pairs

In paired cylinders the pistons move together in the same direction but are on opposite strokes. Cylinder pairs can be identified by dividing the firing order into two equal groups. Then position the last group of numbers under the first group. The numbers that are aligned vertically are paired cylinders. For example, if the firing order of a four cylinder engine is 1 3 4 2, the last two numbers (4 2) are placed under the first two numbers (1 3). The paired cylinders are 1 & 4 and 3 & 2.

ICM

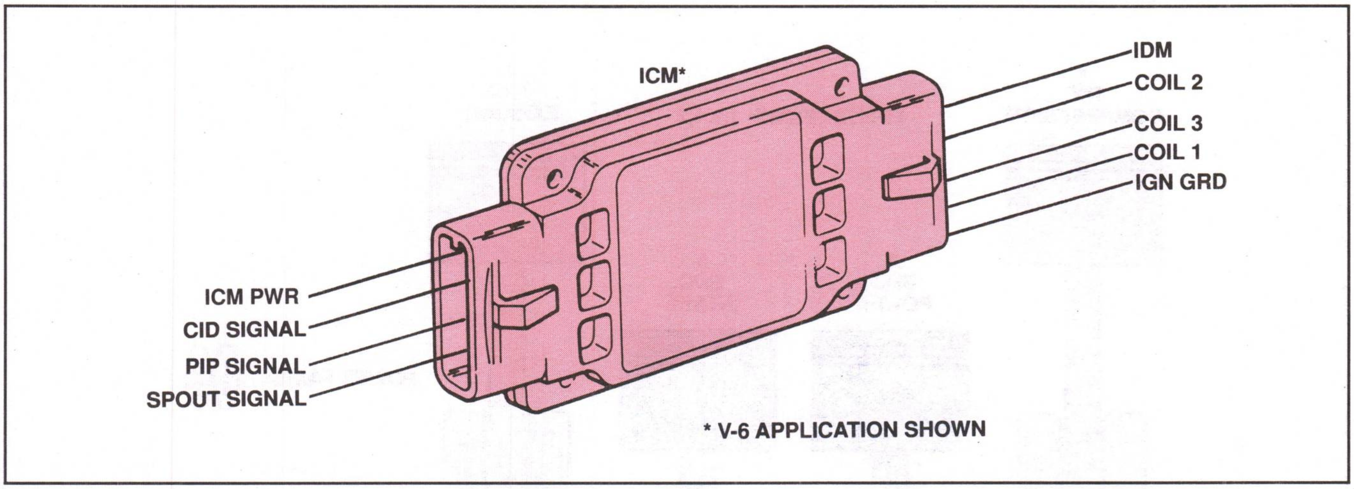


Figure 7-4 — Low data rate ICM

The ICM in the EI – low data rate system performs the same function as the ICM in the DI system. Also, dwell in the EI system is controlled the same way as the DI system with computer controlled dwell. Therefore, many of the ICM circuits in the EI system are similar to the ICM circuits in the DI system. These circuits include the following:

- **ICM Power (ICM PWR)**
- Profile Ignition Pickup (PIP)
- Spark Out (SPOUT)
- **Ignition Ground (IGN GND)**
- **Coil Negative (COIL–)**
  (one for each coil)
- Ignition Diagnostic Monitor (IDM)

However, there are two differences.

- The ICM must control more than one coil. As a result, the ICM used on the EI system has one COIL– circuit for each coil (cylinder pairs).
- Since there is no distributor, a sensor is needed to identify which cylinders should be selected for ignition. The signal is known as the **Cylinder Identification (CID)** signal.

OPERATION

CKP Sensor

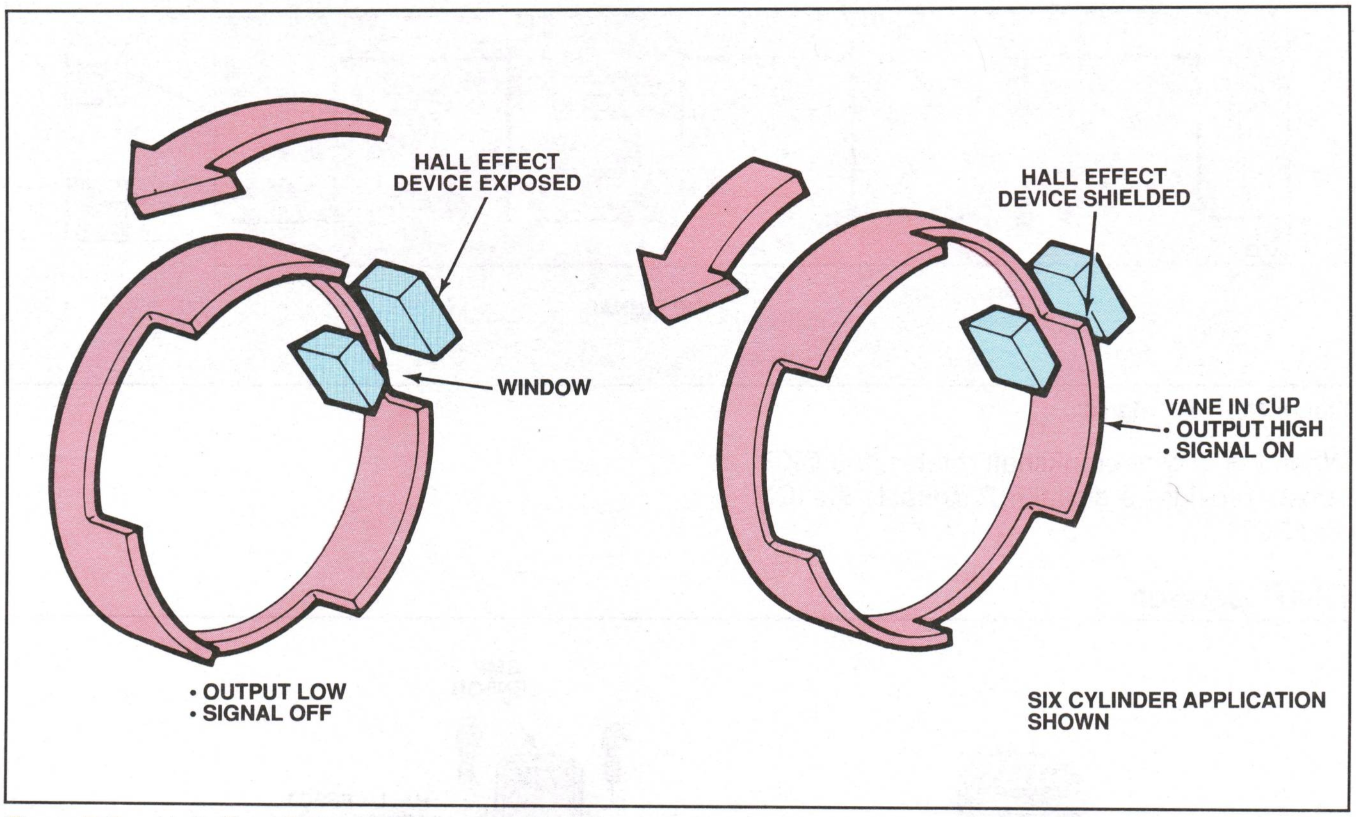


Figure 7-5 — Hall effect CKP sensor

The CKP sensor is a Hall effect sensor that measures crankshaft RPM and supplies a PIP signal. On a four cylinder engine the sensor's armature has two vanes, and on a six-cylinder engine it has three vanes. Each vane produces one signal pulse for each revolution of the engine.

PIP Signal

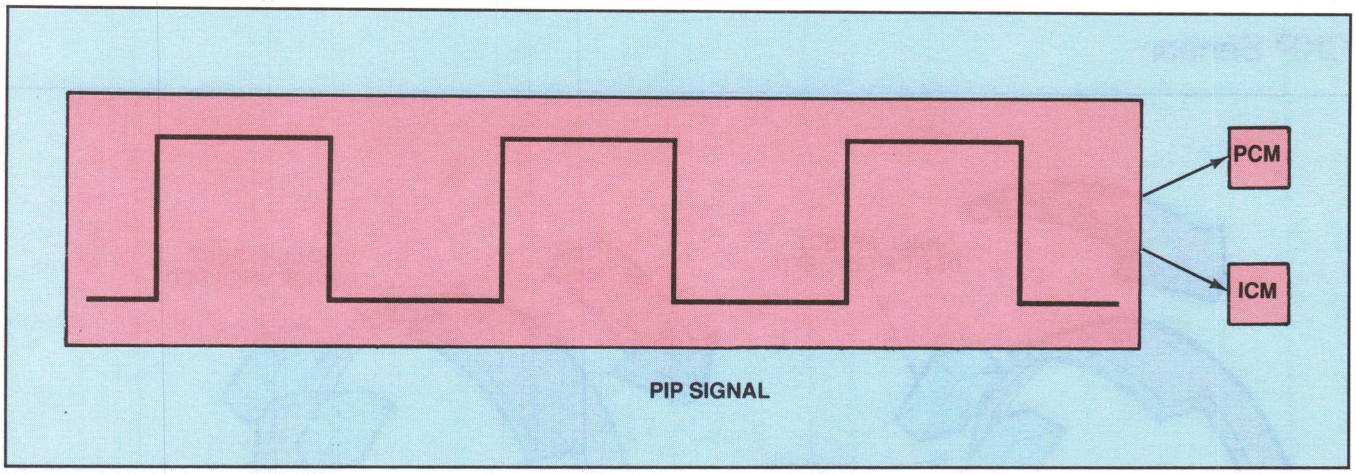


Figure 7-6 — PIP signal

When the engine crankshaft rotates, the CKP sensor provides a digital PIP signal to the ICM and PCM.

CMP Sensor

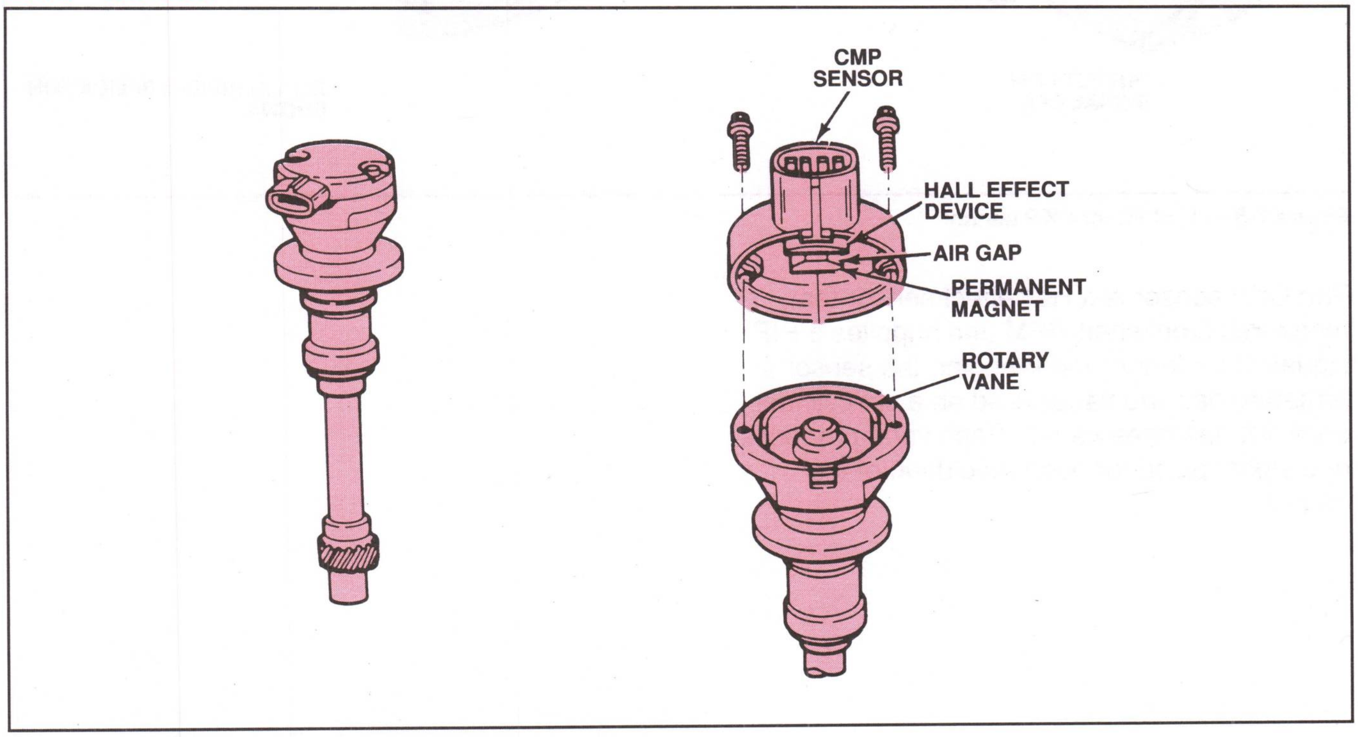


Figure 7-7 — CMP sensor — low data rate ignition system

The CMP sensor sends a **Cylinder Identification (CID)** signal to the ICM and PCM. It is a Hall device driven by the camshaft. It turns at one half the crankshaft speed and produces one pulse signal per camshaft revolution.

The CID signal is used to determine when to fire the coil pack for the #1 cylinder. Once the initial reference is determined, the coil packs fire in sequence according to firing order. Subsequent CID signals are used to verify that the coil pack for cylinder #1 is firing for cylinder #1. Also, CID is used to synchronize actuation of the sequential fuel injectors.

CID and PIP Signals

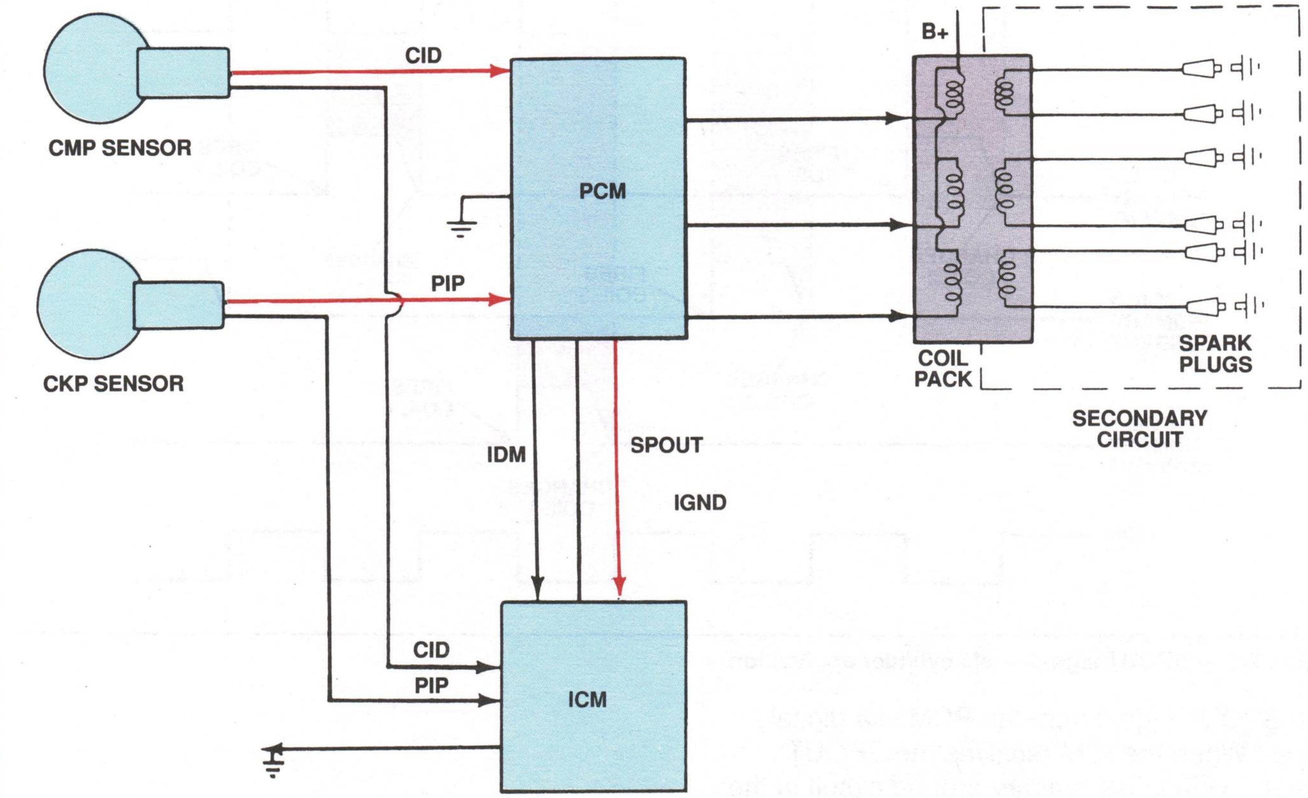


Figure 7-8 — Low data rate system schematic

The CID and PIP signals are used by the PCM, along with other input data, to determine the correct spark timing. The PCM sends a SPOUT signal to the ICM when it is time for the spark.

SPOUT Signal

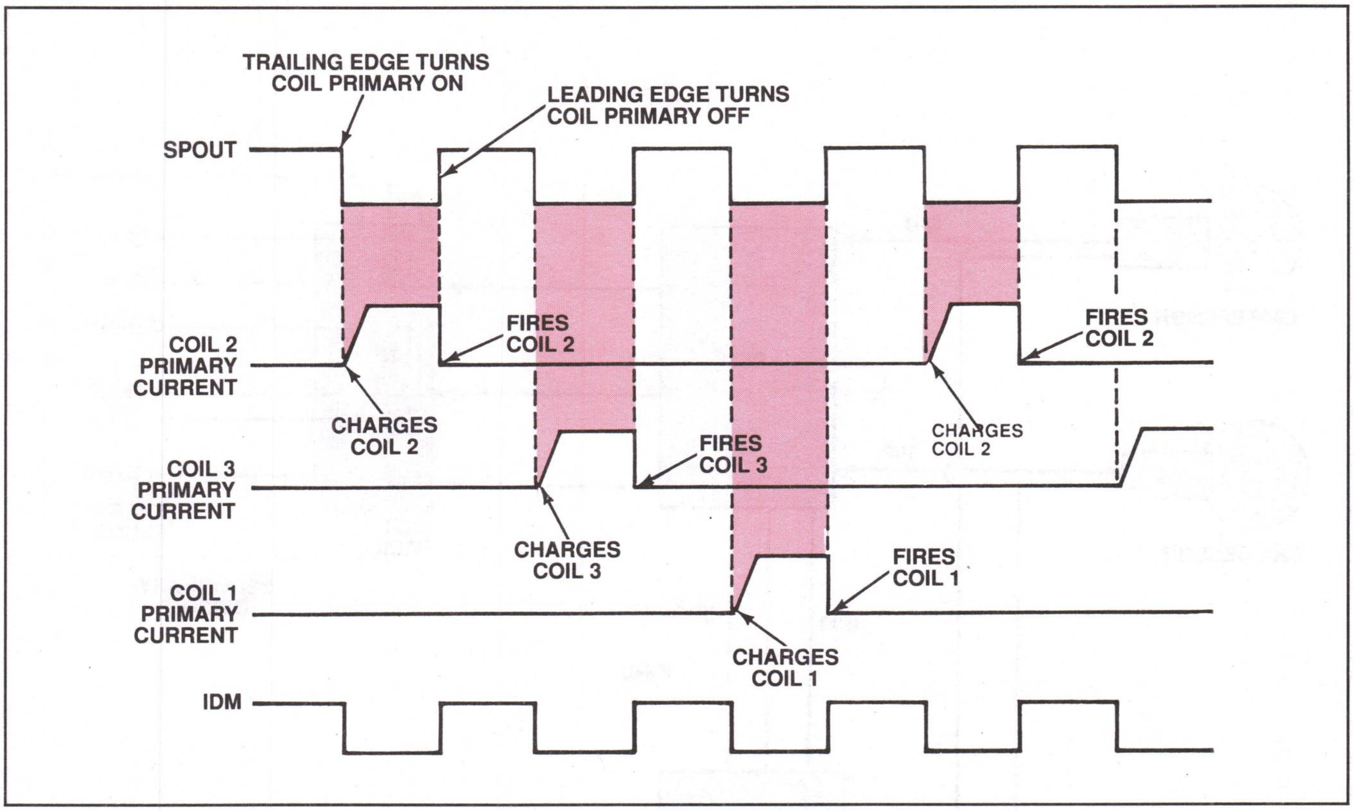


Figure 7-9 — SPOUT signal — six cylinder application

The SPOUT signal from the PCM is a digital signal. When the ICM receives the SPOUT signal, it opens the primary ground circuit in the appropriate coil to fire the spark plug. The CID signal tells the ICM which coil to fire. If the ICM does not receive a CID signal, it will randomly select a coil to fire. Several attempts at starting may be necessary until the correct coil is selected and the engine starts. Once the engine starts the coils are then operated in sequence.

DUAL PLUG EI – LOW DATA RATE SYSTEMS

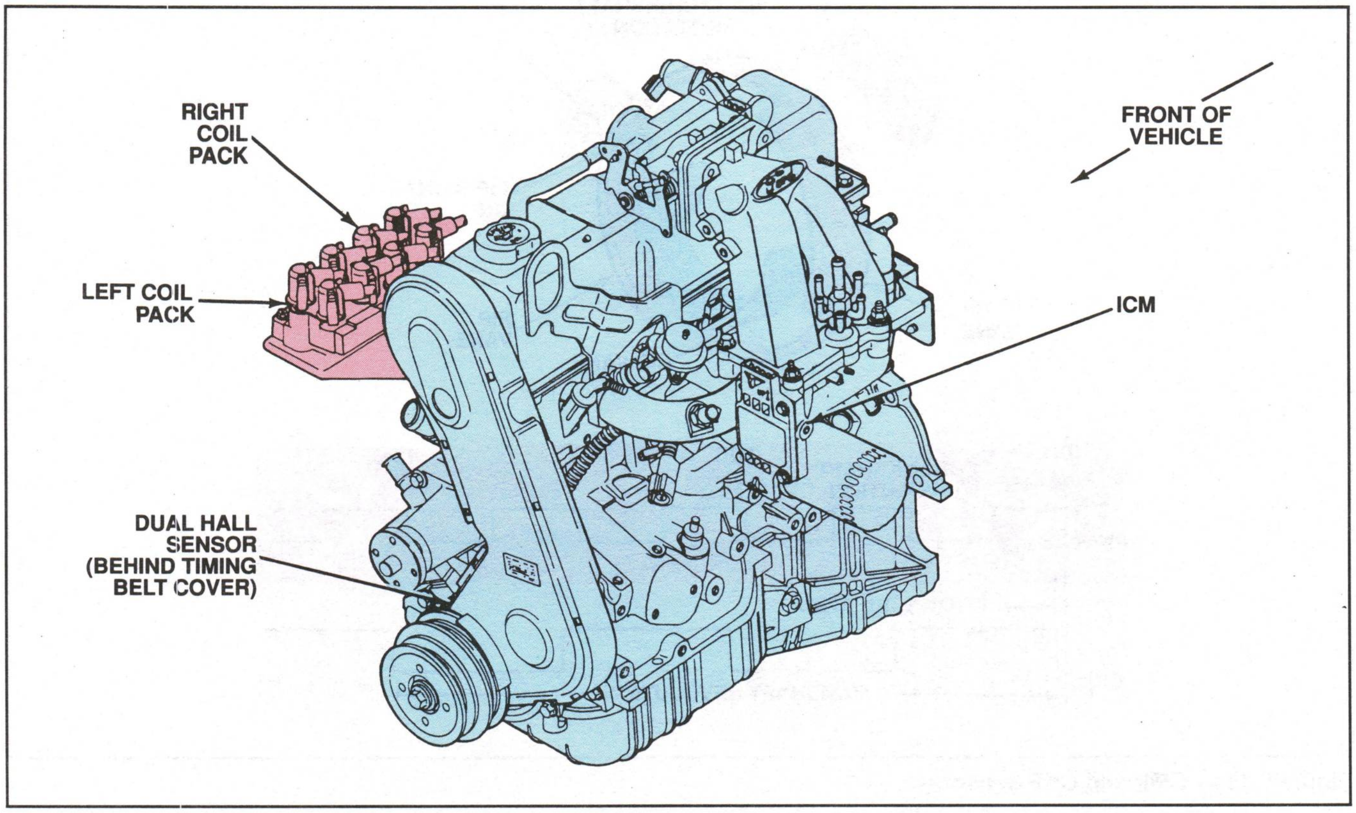


Figure 7-10 — Dual plug low data rate ignition components

The **dual plug** EI system is used on the Mustang and Ranger 2.3L four-cylinder engines. It is a variation of the low data rate system previously covered.

The dual plug EI system has two spark plugs in each cylinder with two identical coil packs. Each coil pack contains two coils. Both coil packs are controlled by one ICM. The CMP and CKP sensors are combined into one unit and are mounted on the crankshaft.

NOTE: Dual plug ignition is used to provide more efficient combustion in the 2.3L engine.

Dual Hall Sensor

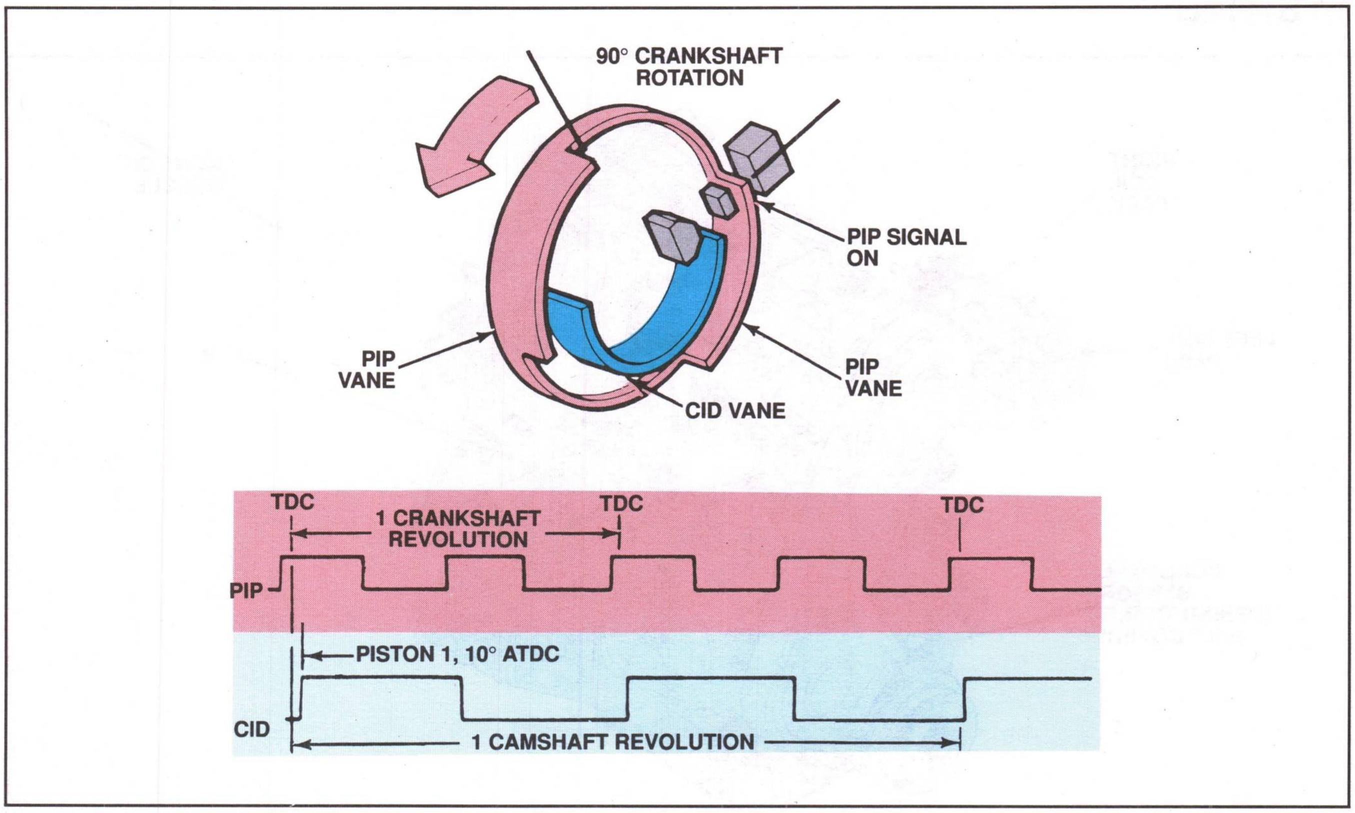


Figure 7-11 — CMP and CKP sensors

The combination CMP and CKP sensors are Hall effect types. The CKP sensor has two vanes. This produces a signal every 90 degrees of crankshaft rotation. The vanes are positioned so that the leading edge of the CKP signal occurs at ten degrees BTDC.

The CMP sensor has one vane. This produces a signal every 180 degrees of crankshaft rotation. The vane is positioned so that the leading edge of the CMP signal occurs at 10 degrees ATDC.

Dual Plug EI System Operation

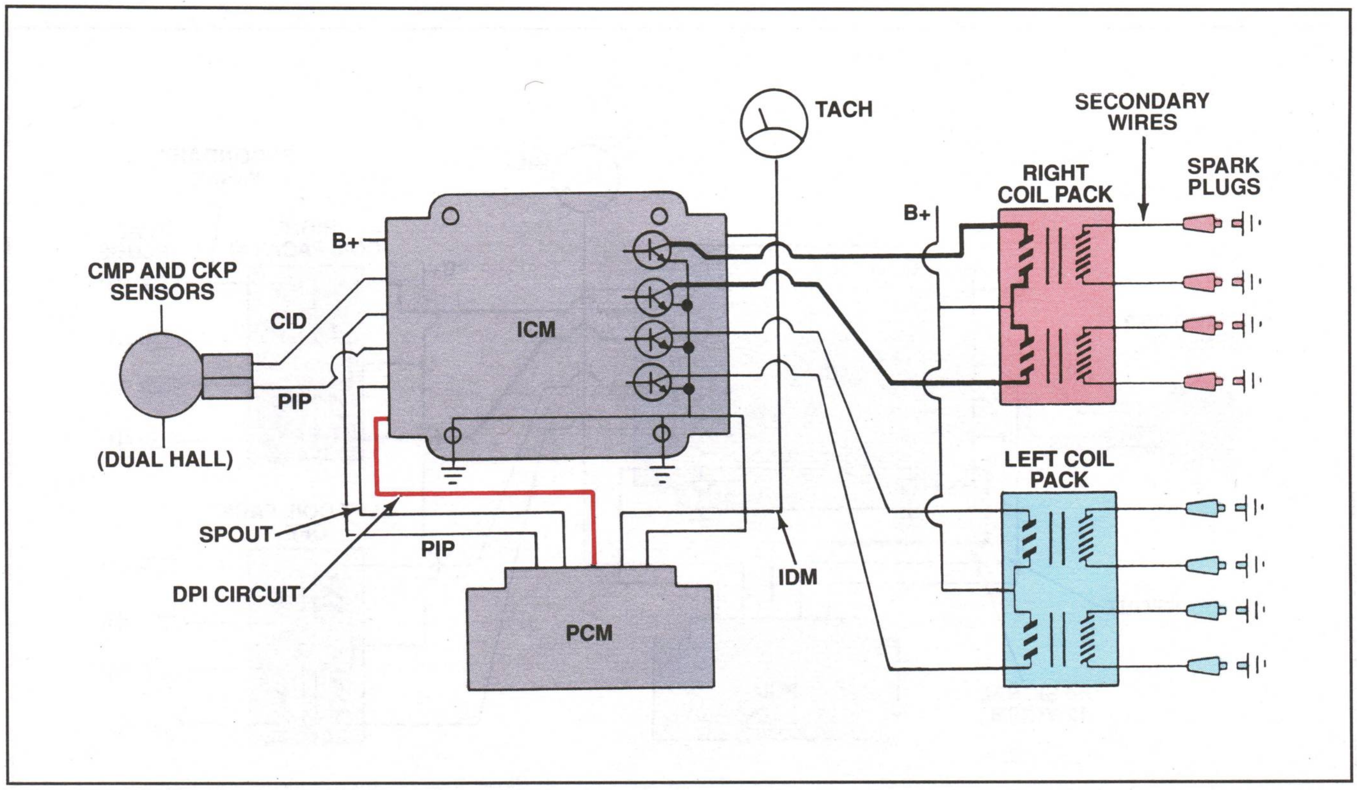


Figure 7-12 — Dual plug schematic — DPI circuit

The coil packs and spark plugs are identified as RIGHT and LEFT. The right coil pack and spark plugs operate continuously. However, the left coil pack and spark plugs may be turned ON or OFF by the PCM. This is done through the **Dual Plug Inhibit (DPI)** circuit.

DPI CIRCUIT

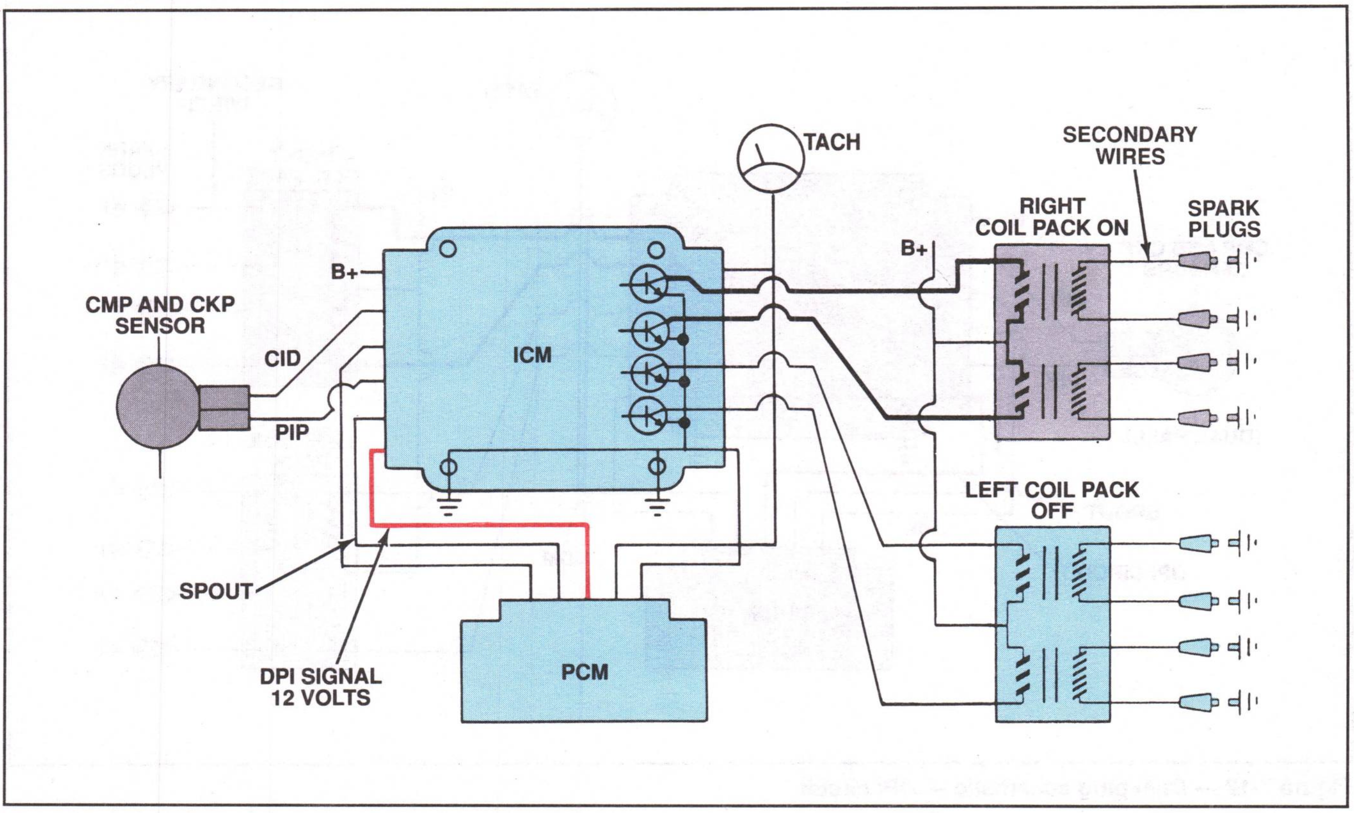


Figure 7-13 — DPI — Operation DPI circuit actuated

The Dual Plug Inhibit (DPI) circuit is added between the PCM and ICM to control the operation of the left coil pack. A high signal from the PCM (12 volts) turns the left coil pack OFF. A low signal (0.1 volts) turns the left coil pack ON.

On the 2.3L Mustang, both coil packs are activated during cranking and running. If the temperature is less than -7 degrees C (20 degrees F), the PCM will turn OFF the left coil pack until the engine is running.

On the 2.3L Ranger, the left coil pack is always turned OFF during cranking. Both coil packs operate when the engine is running.

Repetitive Spark

Some EI – low data rate ignition systems are designed to produce more than one spark per ignition firing.

LOW DATA RATE DIAGNOSIS AND TESTING

The following information pertains to the diagnosis and testing of the following EI low data rate circuits and/or components:

- Spark Output (SPOUT)
- Ignition Control Module (ICM)
- Crankshaft Position (CKP) sensor — Profile Ignition Pickup (PIP) signal
- Cylinder Identification (CID) signal — Camshaft Position (CMP) sensor
- Dual Plug Inhibit (DPI) circuit

SPOUT Signal Test

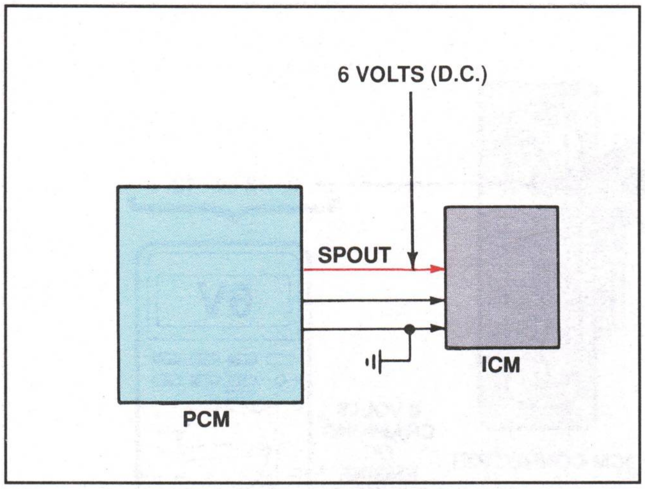


Figure 7-14 — SPOUT signal test

The SPOUT signal is the same on this EI system as it is on the DI system. It is a digital signal sent by the PCM. It is checked in a similar manner to DI systems.

ICM Test

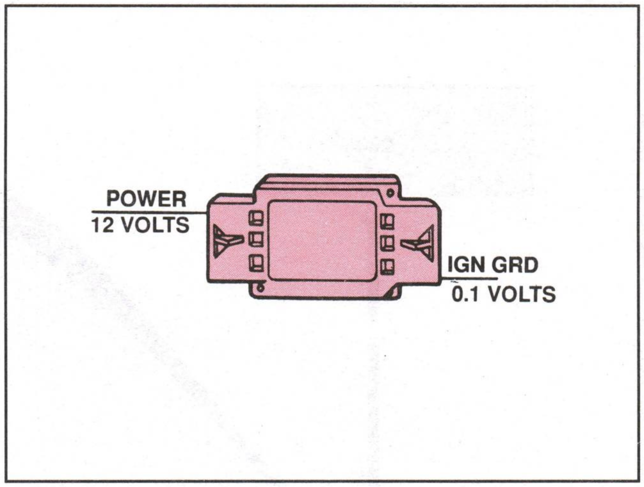


Figure 7-15 — ICM Power and Ground Test

The ICM has the same voltage and ground requirements as the ICM used in the DI system. A DVOM can detect power and ground voltages.

CKP Sensor

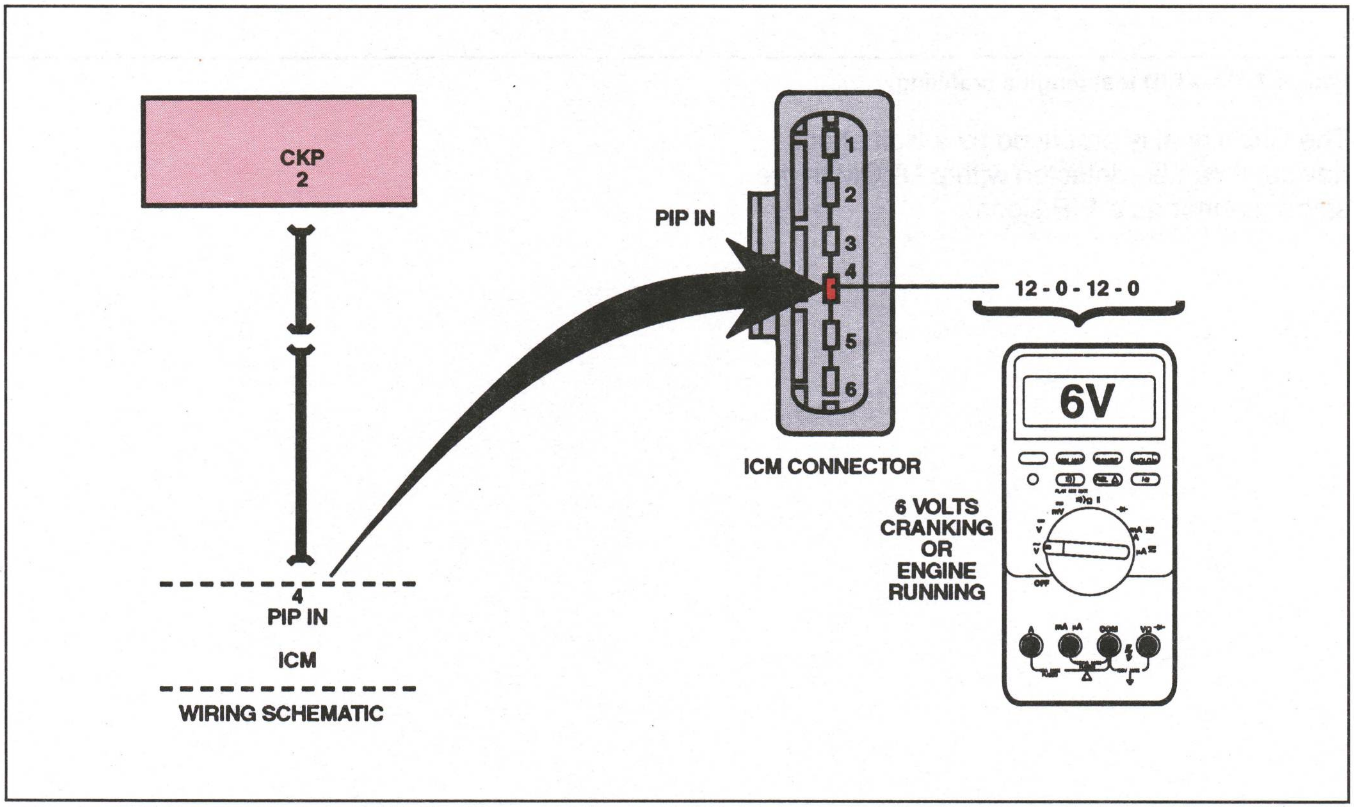


Figure 7-16 — CKP test

The CKP sensor is a Hall effect device that operates in much the same way as the Hall device used in the DI system. A DVOM can detect the signal in the same manner.

CID Signal Test

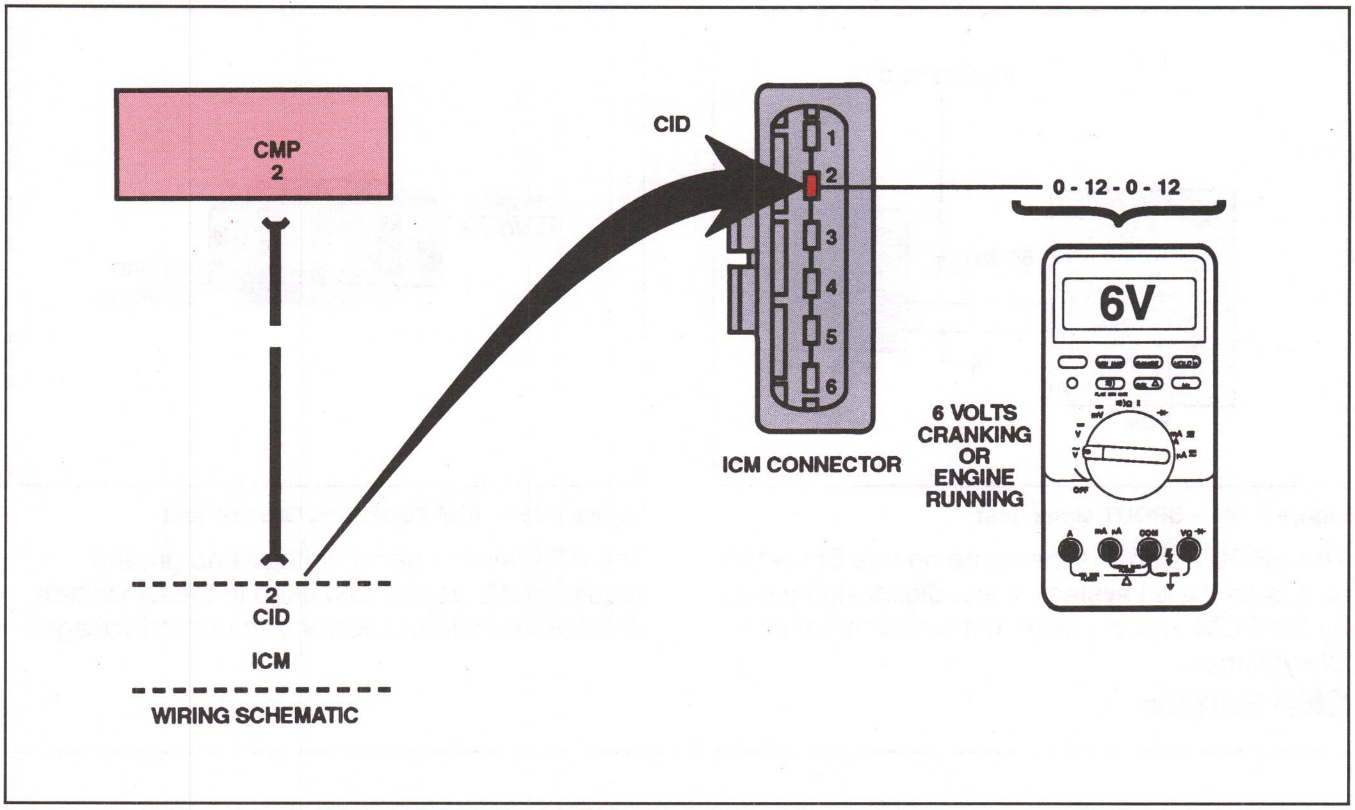
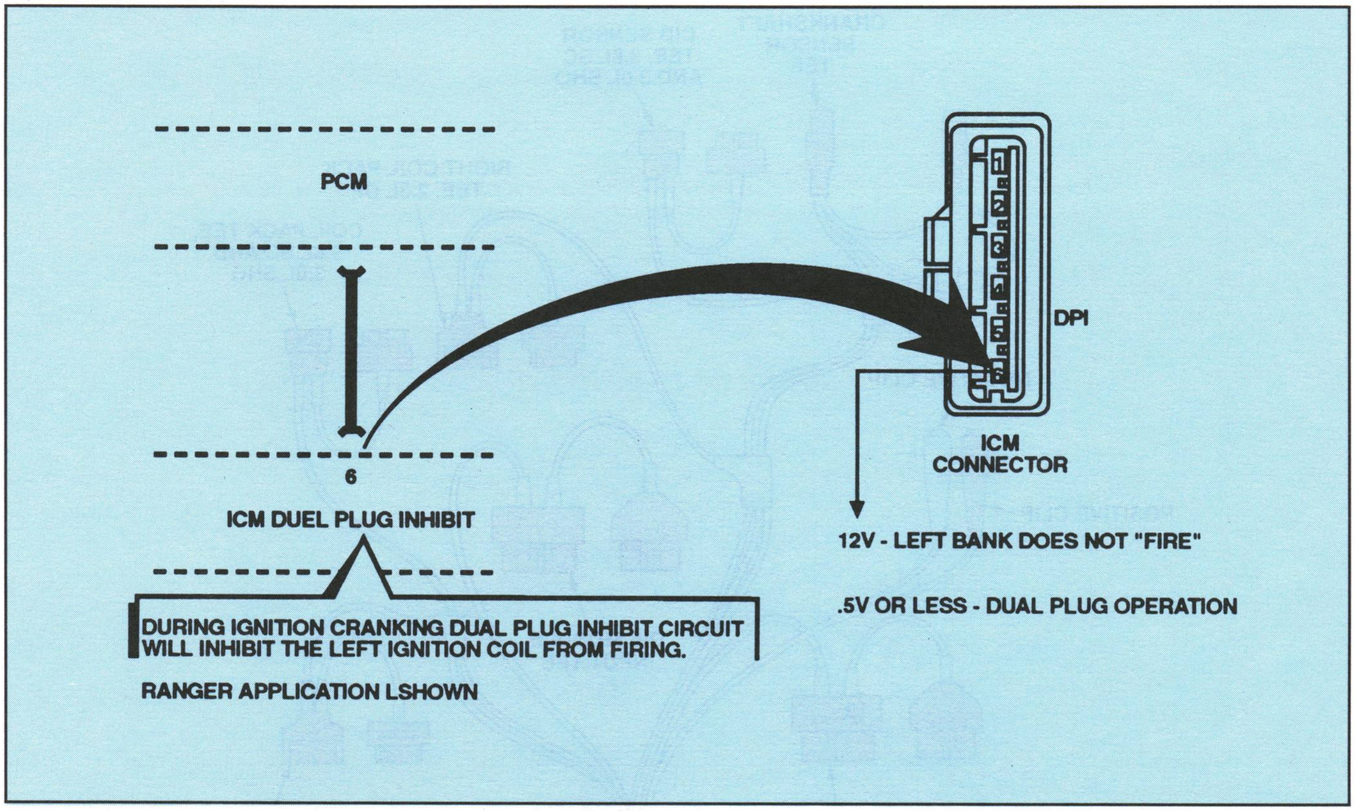


Figure 7-17 — CID test (engine cranking)

The CID signal is produced by a Hall effect device. It can be detected with a DVOM in the same manner as a PIP signal.

DPI Circuit Test


PCM
6
ICM DUEL PLUG INHIBIT
DPI
ICM
CONNECTOR
12V - LEFT BANK DOES NOT "FIRE"
.5V OR LESS - DUAL PLUG OPERATION
RANGER APPLICATION LSHOWN

DURING IGNITION CRANKING DUAL PLUG INHIBIT CIRCUIT WILL INHIBIT THE LEFT IGNITION COIL FROM FIRING.

Figure 7-18 — DPI test

When the PCM wants to prevent the left bank plugs from firing, it sends out a high voltage signal to the ICM on the DPI circuit. A DVOM can be used to detect the presence of a DPI signal. With the key on or engine running, high voltage (12-14 volts) indicates that dual plug function was stopped. A low voltage (.5 volts or less) indicates that dual plug function was not stopped (both banks operate).

NOTE: Always refer to the PCED manual for specific instructions and specifications when performing diagnostic tests.

SPECIALTY DIAGNOSTIC EQUIPMENT

Special test equipment is available for low data rate ignition system diagnosis:

- **Distributorless Ignition System (DIS)** diagnostic harness
- EEC IV Breakout Box (BOB)
- EEC IV monitor
- **Overlays** (for use with BOB and monitor)
- DIS module tester

DIS Diagnostic Harness

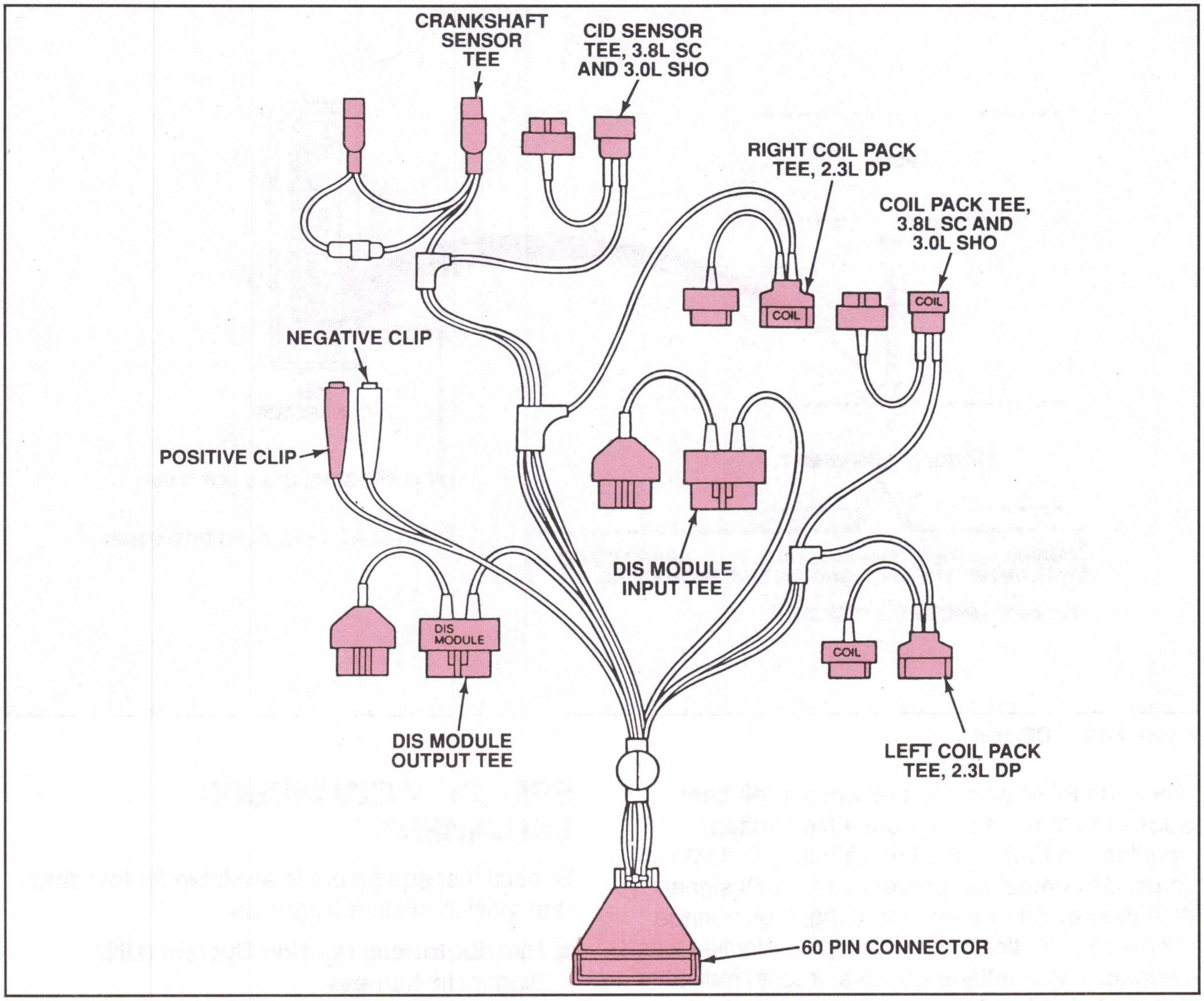

CRANKSHAFT SENSOR TEE
CID SENSOR TEE, 3.8L SC AND 3.0L SHO
RIGHT COIL PACK TEE, 2.3L DP
COIL PACK TEE, 3.8L SC AND 3.0L SHO
COIL
COIL
NEGATIVE CLIP
POSITIVE CLIP
DIS MODULE INPUT TEE
DIS MODULE
DIS MODULE OUTPUT TEE
COIL
LEFT COIL PACK TEE, 2.3L DP
60 PIN CONNECTOR

Figure 7-19 — DIS diagnostic harness hookup

The DIS diagnostic harness is used with either the EEC IV BOB or EEC IV monitor. The harness serves as a link between the BOB or monitor and the low data rate system. This set-up allows you to access many of the low data rate circuits from one spot.

Leads from the harness connect to the low data rate components on the vehicle. The 60 pin connector from the harness is connected to either the BOB or monitor.

EEC IV BOB

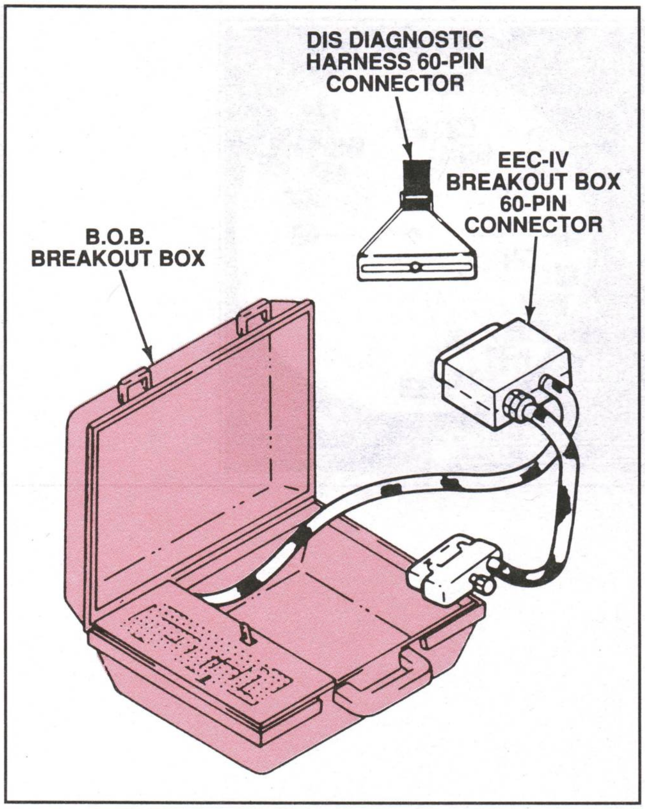

DIS DIAGNOSTIC HARNESS 60-PIN CONNECTOR
EEC-IV BREAKOUT BOX 60-PIN CONNECTOR
B.O.B. BREAKOUT BOX

Figure 7-20 — EEC-IV BOB

The EEC IV BOB contains 60 pins that allow you to use a DVOM to check circuit voltages or resistance. When the DIS harness is connected to the BOB, you have access to many low data rate circuits through the pins of the BOB.

EEC IV Monitor

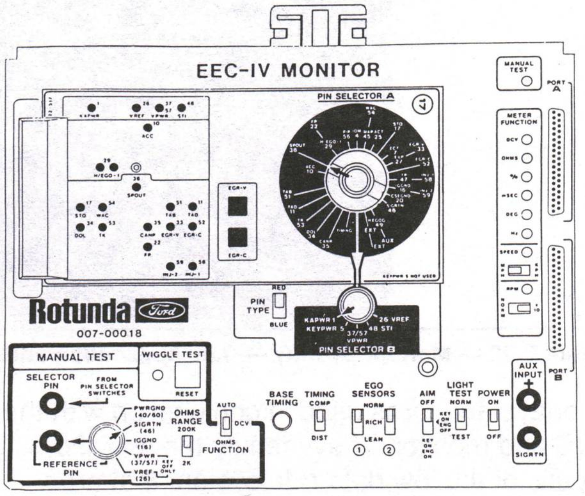


Figure 7-21 — EEC-IV monitor

The EEC IV monitor serves the same purpose as the BOB. It allows you to access many low data rate circuits from one location, when connected to the DIS harness. The monitor operates differently from the BOB. Circuits are selected with a dial located on the main unit, and readings are displayed on a remote display unit.

Overlays

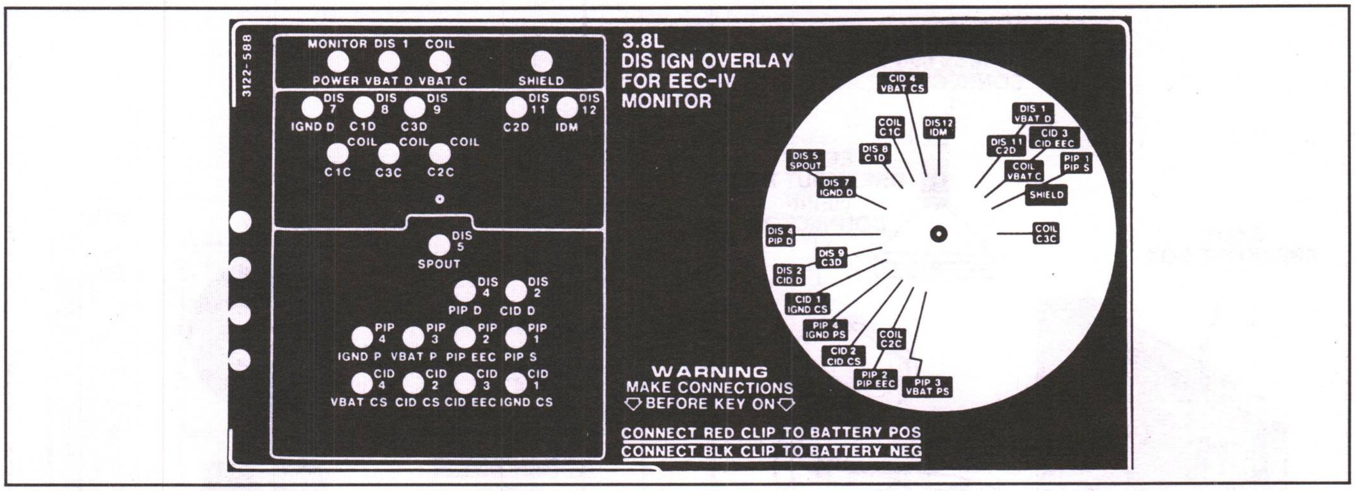


Figure 7-22 — Monitor overlay — 3.8L application shown

Overlays are cards used in conjunction with the BOB and monitor. They identify the specific circuits of the low data rate system that are accessible through the tester.

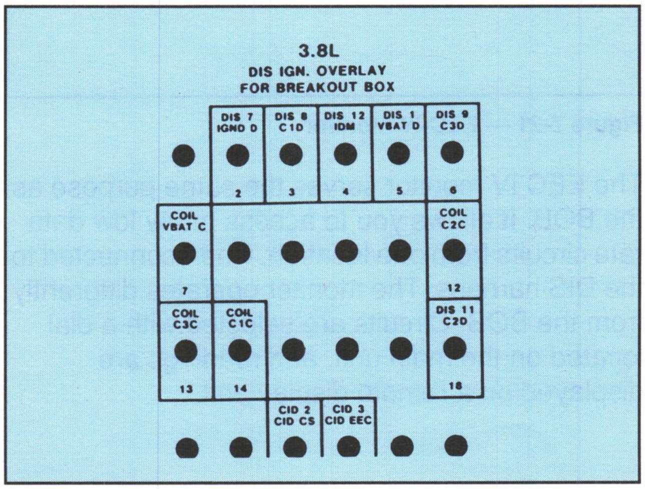


Figure 7-23 — BOB overlay — 3.8L application shown

DIS Module Tester

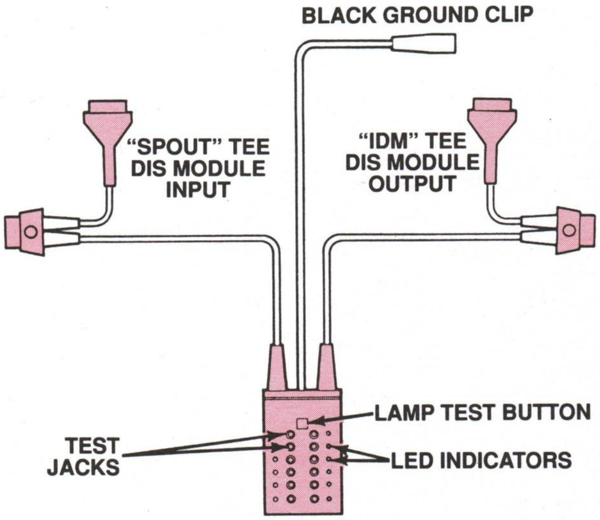


Figure 7-24 — DIS tester hookup

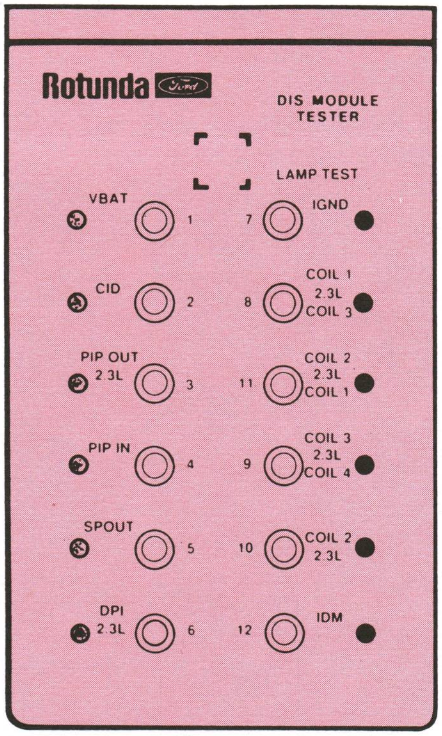


Figure 7-25 — DIS tester

The DIS module tester is used to check the input and output signals of the low data rate ICM. The tester contains Light Emitting Diodes (LEDs) which identify specific circuits. Tees from the tester are connected to the vehicle's wiring harness and ICM. This tester allows access to many of the same circuits as the DIS harness. The DIS module tester can be used as an alternative to the DIS harness.

NOTE: Refer to the PCED manual and other appropriate service manuals for information on installing and using test equipment.

EI — LOW DATA RATE SYSTEM REFERENCE MATERIAL

Additional information about the EI – low data rate ignition system can be obtained from the "Distributorless Ignition Systems" reference manual. Course number 2301-103.

This is the end of Lesson 7. Now view Lesson 7 on the video tape, and answer the Progress Check questions.

EI — LOW DATA RATE IGNITION SYSTEM

LESSON 7 – PROGRESS CHECK QUESTIONS

The following questions are based on the information contained in Lesson 7. Choose the **ONE** best correct answer. The answers are provided on the following page. Review any questions missed before proceeding to the next lesson.

1. The EI – low data rate system does not:

   A. use a PIP signal.

   B. control dwell.

   C. use a distributor.

   D. control timing.

2. Technician A says that a CMP sensor is used to supply a CID signal to the PCM. Technician B says the EI – low data rate system "fires" spark plugs on both the compression and exhaust strokes. Who is correct?

   A. Technician A

   B. Technician B

   C. Both A and B

   D. Neither A nor B

3. Technician A says the EI – low data rate system does not use Hall effect devices. Technician B says that many of the signals exchanged between the ICM and PCM, in the EI – low data rate system, are the same as those exchanged with the DI system. Who is correct?

   A. Technician A

   B. Technician B

   C. Both A and B

   D. Neither A nor B

4. Technician A says DP EI – low data rate systems do not "fire" spark plugs in cylinder pairs. Technician B says the DP EI – low data rate system contains a DPI circuit which operates the right coil pack. Who is correct?

   A. Technician A

   B. Technician B

   C. Both A and B

   D. Neither A nor B

LESSON 7 – PROGRESS CHECK ANSWERS

1. The EI – low data rate system does not:

   A. use a PIP signal.

   B. control dwell.

   [✓ C.] use a distributor.

   D. control timing.

   The EI system electronically fires individual coal packs. These packs deliver the secondary voltage directly to the spark plugs without the need for a distributor to direct the voltage.

2. Technician A says that a CMP sensor is used to supply a CID signal to the PCM. Technician B says the EI – low data rate system "fires" spark plugs on both the compression and exhaust strokes. Who is correct?

   A. Technician A

   B. Technician B

   [✓ C.] Both A and B

   D. Neither A nor B

   The CMP sensor does provide a CID signal; and the EI system "fires" paired cylinders on the compression and exhaust strokes.

3. Technician A says the EI – low data rate system does not use Hall effect devices. Technician B says that many of the signals exchanged between the ICM and PCM, in the EI – low data rate system, are the same as those exchanged with the DI system. Who is correct?

   A. Technician A

   [✓ B.] Technician B

   C. Both A and B

   D. Neither A nor B

   Hall effect sensors are used in this EI system; and many of the signals exchanged between the PCM and ICM are the same for both the DI and EI systems.

4. Technician A says DP EI – low data rate systems do not "fire" spark plugs in cylinder pairs. Technician B says the DP EI – low data rate system contains a DPI circuit which operates the right coil pack. Who is correct?

   A. Technician A

   B. Technician B

   C. Both A and B

   [✓ D.] Neither A nor B

   DP EI systems "fire" spark plugs in cylinder pairs. The DPI circuit controls the left bank coil.

LESSON 7 – PROGRESS CHECK QUESTIONS (CONT'D.)

5. Technician A says the BOB and DIS harness can be used to check the function of the DPI circuit. Technician B says if the voltage on the DPI circuit is 0.2 volts the left bank plugs are inoperative. Who is correct?

   A. Technician A

   B. Technician B

   C. Both A and B

   D. Neither A nor B

LESSON 7 – PROGRESS CHECK ANSWERS (CONT'D.)

5. Technician A says the BOB and DIS harness can be used to check the function of the DPI circuit. Technician B says if the voltage on the DPI circuit is 0.2 volts the left bank plugs are inoperative. Who is correct?

   [✓ A.] Technician A
   B. Technician B
   C. Both A and B
   D. Neither A nor B

   The DIS harness and BOB can be used to check the DPI circuit, as well as other EI circuits. A DPI voltage of 0.2 indicates that the left coil pack is operating.

IGNITION SYSTEM THEORY AND OPERATION

Lesson 1	Spark and Ignition
Lesson 2	Basic Ignition
Lesson 3	Ignition Requirements and Operating Modes
Lesson 4	Ignition Related Driveability Symptoms
Lesson 5	Basic Testing

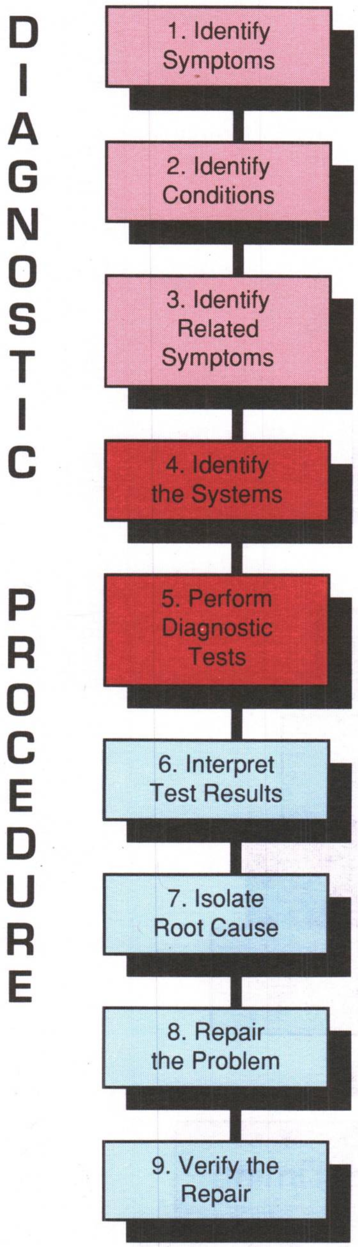
NAAO

Lesson 6	DI Ignition System
Lesson 7	EI – Low Data Rate Ignition System
Lesson 8	EI – High Data Rate Ignition System
Lesson 9	EEC System Diagnosis

ASSOCIATION

Lesson 10	DI Electronically Controlled Timing
Lesson 11	DI Mechanically Controlled Timing
Lesson 12	Villager DI Ignition System

EI – HIGH DATA RATE IGNITION SYSTEM



LESSON 8: EI: HIGH DATA RATE IGNITION SYSTEM

Where does this lesson fit into the diagnostic procedure?

The information in this lesson relates to steps 4 and 5 of the diagnostic procedure. It covers the operation, diagnosis and testing of the EI – high data rate ignition system.

Objective(s):

The information in this lesson will enable you to:

- Identify and describe the operation of the ignition system components and describe their functions in operating as a system.
- Idneify and describe ignition system diagnostic procedures and test equipment.

EI – HIGH DATA RATE IGNITION SYSTEM

DESCRIPTION

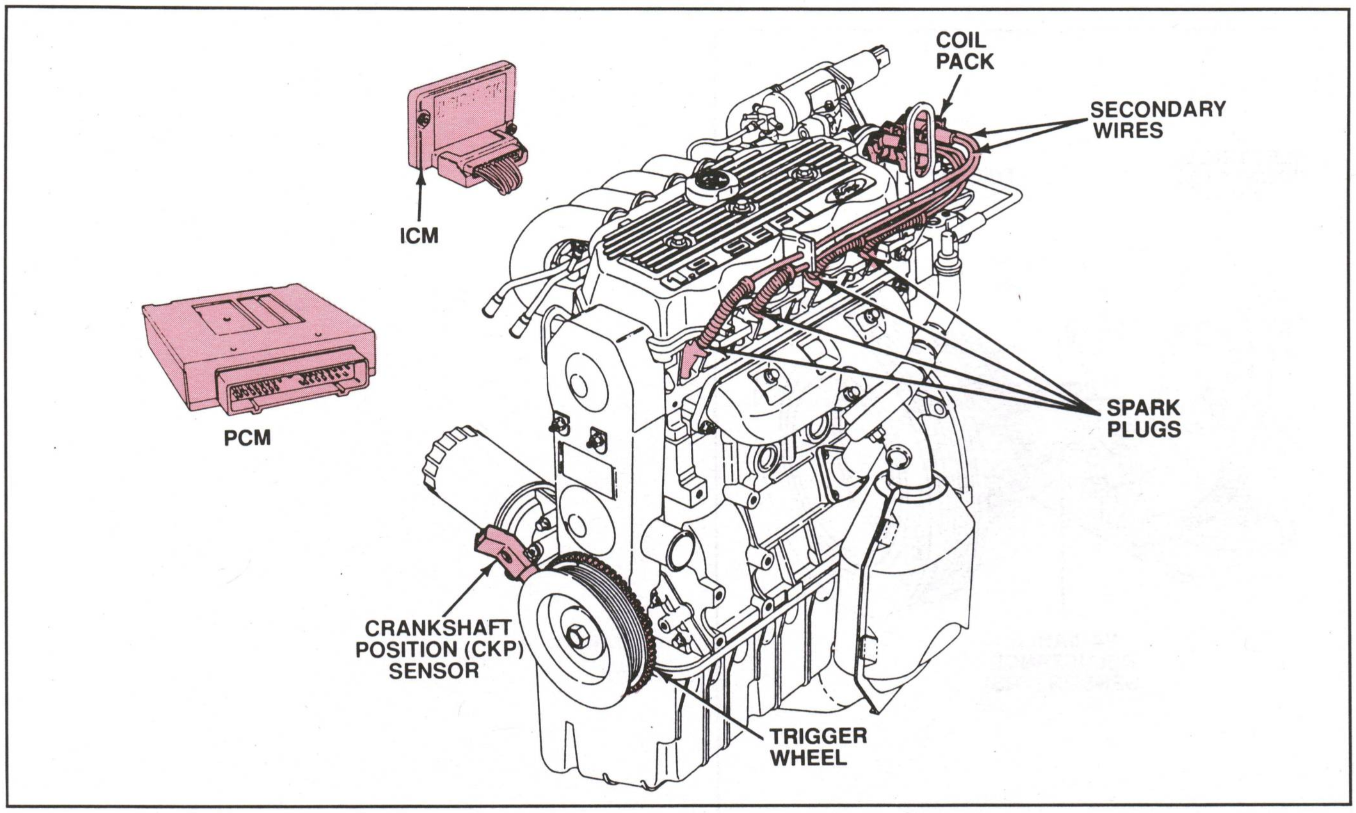


Figure 8-1 — high data rate components

There are many similarities between the EI – low data rate and high data rate ignition systems. Both systems have the following similar features:

- Coil packs that contain multiple coils
- Spark plugs that are fired in paired cylinders
- Do not use distributers to distribute secondary voltage.

However, there are some differences between the two EI systems. These differences are as follows:

- Only one sensor is used to identify cylinders, crankshaft position and engine RPM.
- The signals and communication between the PCM and ICM and the strategy used to determine ignition timing differ.

The components in the EI – high data rate system include:

- PCM
- Ignition Control Module (ICM)
- Crankshaft Position (CKP) sensor
- Trigger wheel
- Coil pack(s)
- Secondary wires
- Spark plugs

CKP Sensor

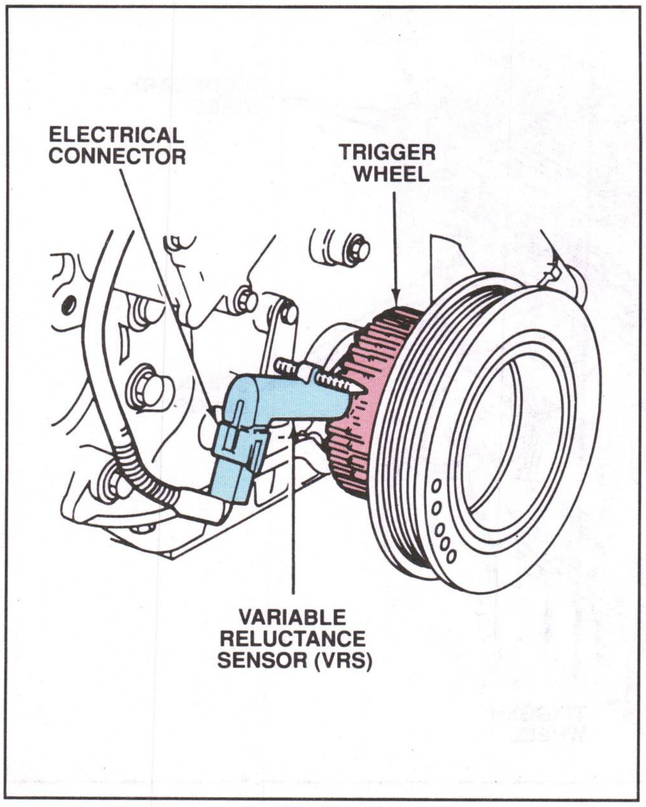


Figure 8-2 — VRS and trigger wheel

The Crankshaft Position (CKP) sensor identifies cylinders, crankshaft position and engine RPM. It generates a signal as the trigger wheel rotates.

The trigger wheel is located on the crankshaft pulley. It has 35 teeth which are spaced ten degrees apart. One missing tooth region provides a larger empty space between two teeth. This empty space provides the Cylinder Identification (CID) signal.

CKP Signal

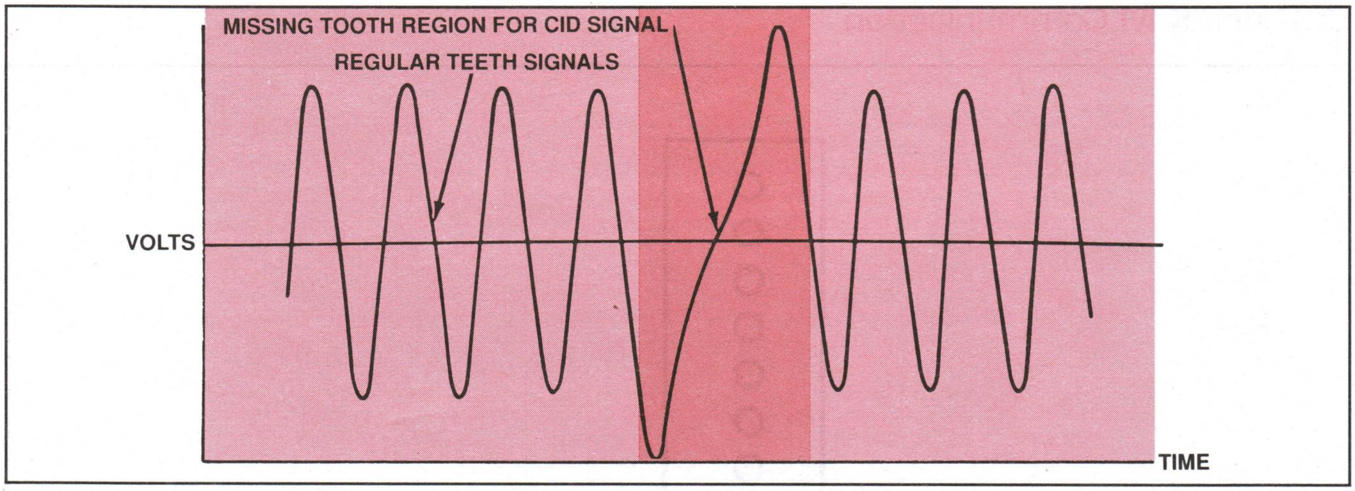


Figure 8-3 — CKP AC signal

The CKP produces 35 **alternating current (AC)** signals for each revolution of the engine. These signals indicate crankshaft position and speed. The 36th tooth is missing. This causes a signal gap so that cylinder #1 can be identified.

OPERATION

CKP and ICM Communication

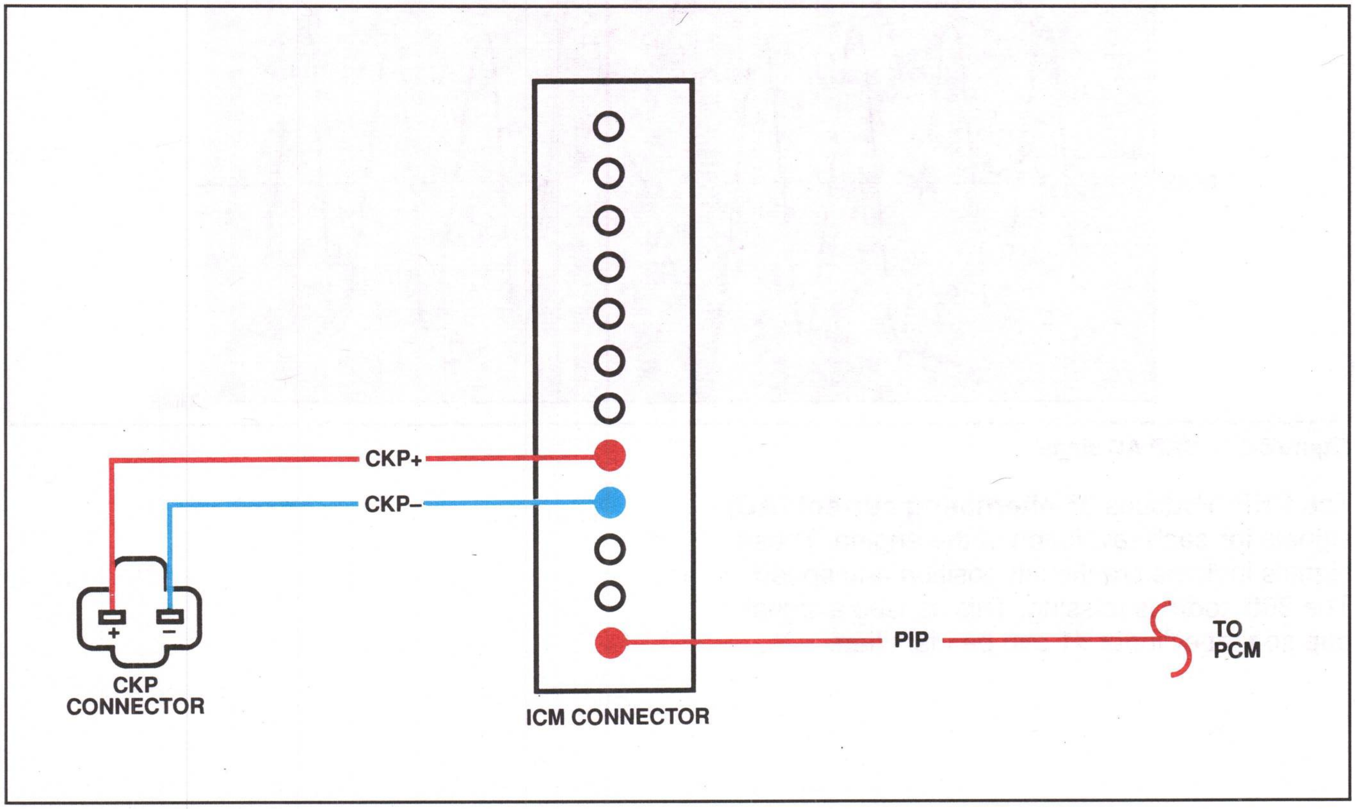


Figure 8-4 — CKP circuits

The AC signal produced by the CKP sensor is sent to the ICM. After receiving the CKP signal, the ICM produces a PIP signal which is sent to the PCM. The PIP signal provides the PCM with cylinder identification, engine speed and crankshaft position information.

PCM and ICM Communication

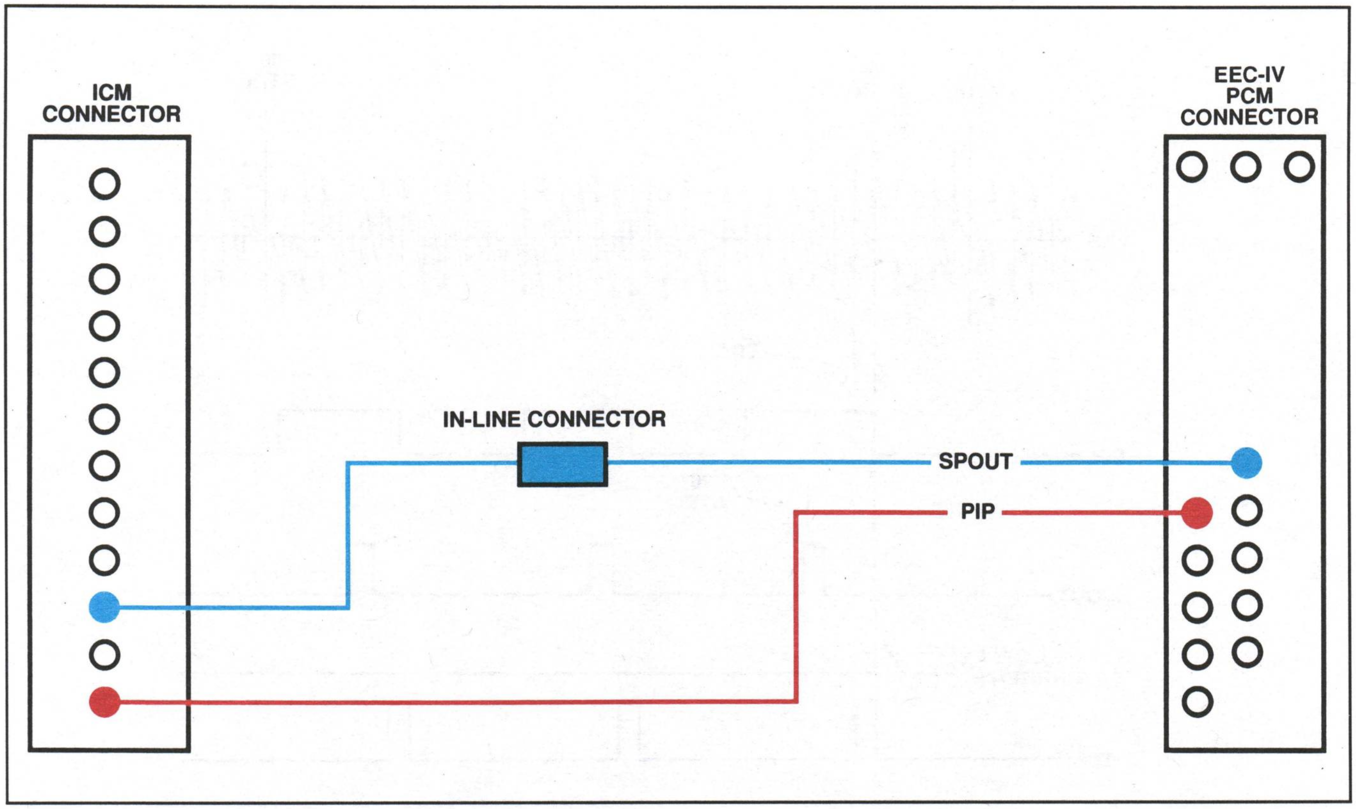


Figure 8-5 — SPOUT and PIP circuits

The PCM processes the PIP signal, along with signals indicating engine load, engine speed, and engine temperature. Based on these inputs, the PCM determines the correct ignition timing and generates a SPOUT signal. The SPOUT signal is sent to the ICM.

ICM and Ignition Timing

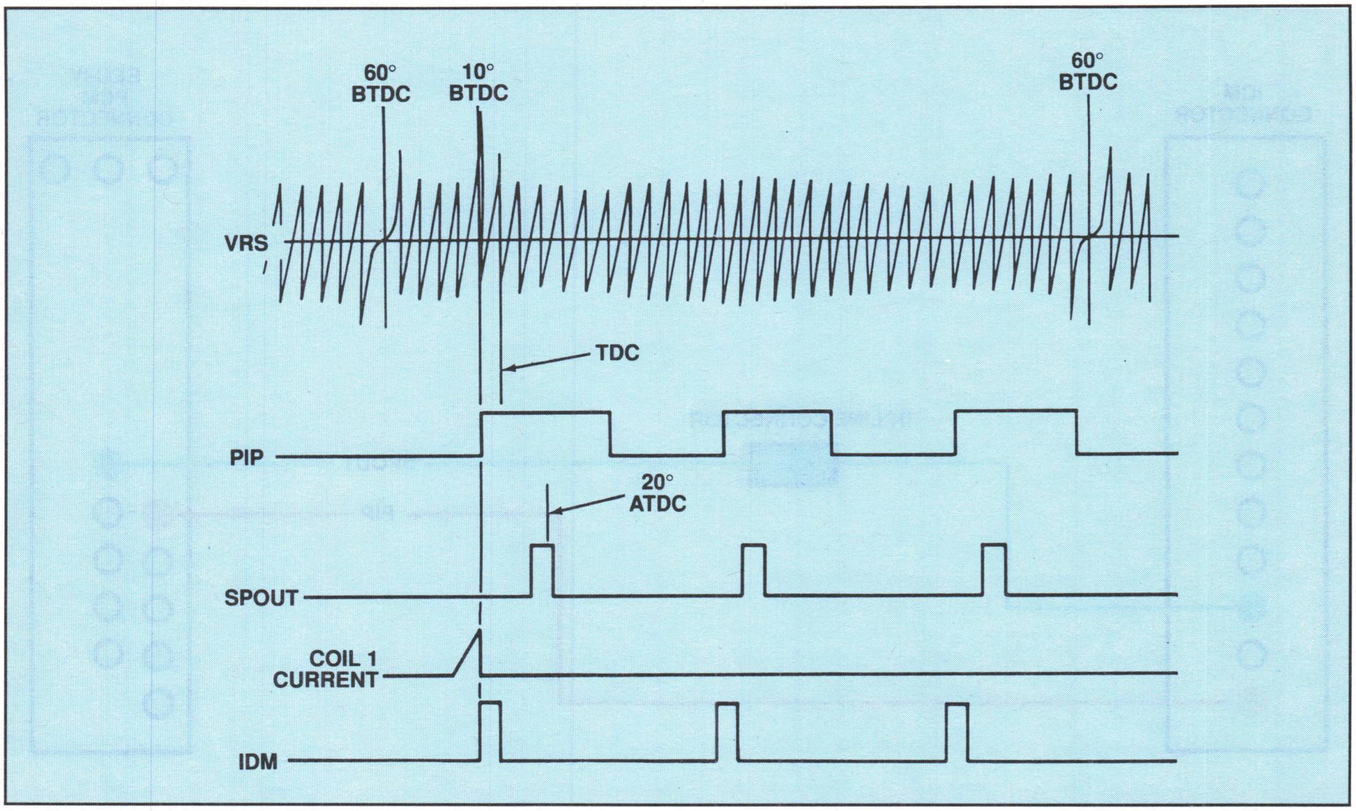


Figure 8-6 — Coil control

The ICM turns the ignition coils ON and OFF at the correct time and in the proper sequence.

- Ignition timing: The ICM uses the SPOUT signal to determine when to fire the spark plugs.
- Coil sequence: The ICM uses the CKP signal to determine which coil to fire.

When the spark plug is fired, the ICM sends an IDM signal to the PCM. This signal provides the PCM with diagnostic information and confirms that a coil did fire. The IDM signal is also used to operate the vehicle's tachometer.

EI – HIGH DATA RATE DIAGNOSIS AND TESTING

Many of the PCM and ICM circuits in the high data rate system are similar to the circuits used in the low data rate system. Therefore they are tested in much the same way. The CKP is the only unique component.

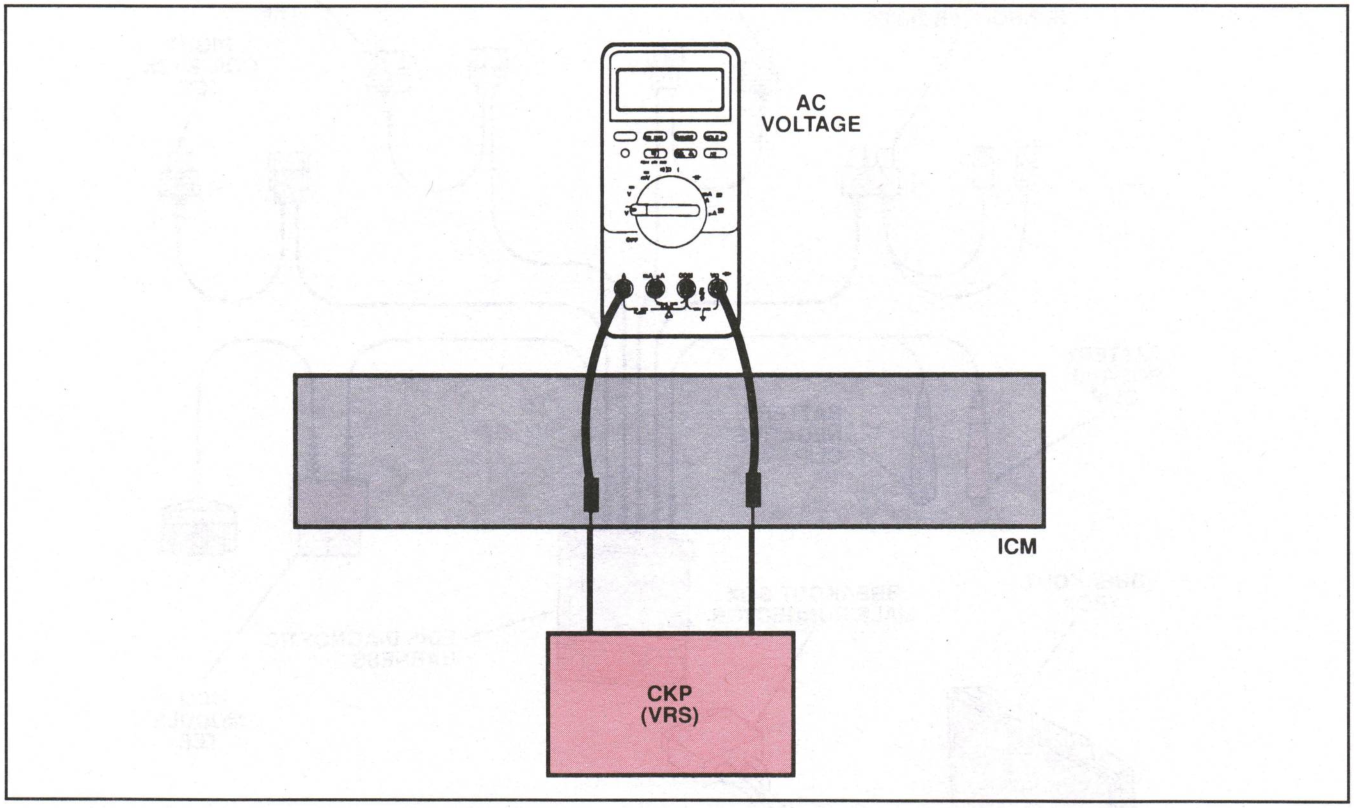


Figure 8-7 — CKP testing

CKP

The CKP generates an AC voltage as the trigger wheel rotates. This voltage can be detected with a DVOM set to register AC volts. Typical cranking voltage is 3.5 volts AC.

CKP Bias Voltage

To prevent signal interference and distortion the ICM puts out a low voltage on the CKP(+) and CKP (–) circuits. This voltage can be checked using a DVOM. Refer to the PCED manual's "Ignition Systems" section for specific procedures and testing methods.

SPECIALTY DIAGNOSTIC EQUIPMENT

Specialty diagnostic equipment for the high data rate system is similar, or the same as, equipment used for the low data rate system. Equipment includes:

- **Electronic Distributorless Ignition System (EDIS)** diagnostic harness
- EEC IV BOB
- Overlays

EDIS Diagnostic Harness and BOB

The EDIS diagnostic harness serves the same purpose as the harness used for the low data rate system. It provides a link between the high data rate circuits and the BOB.

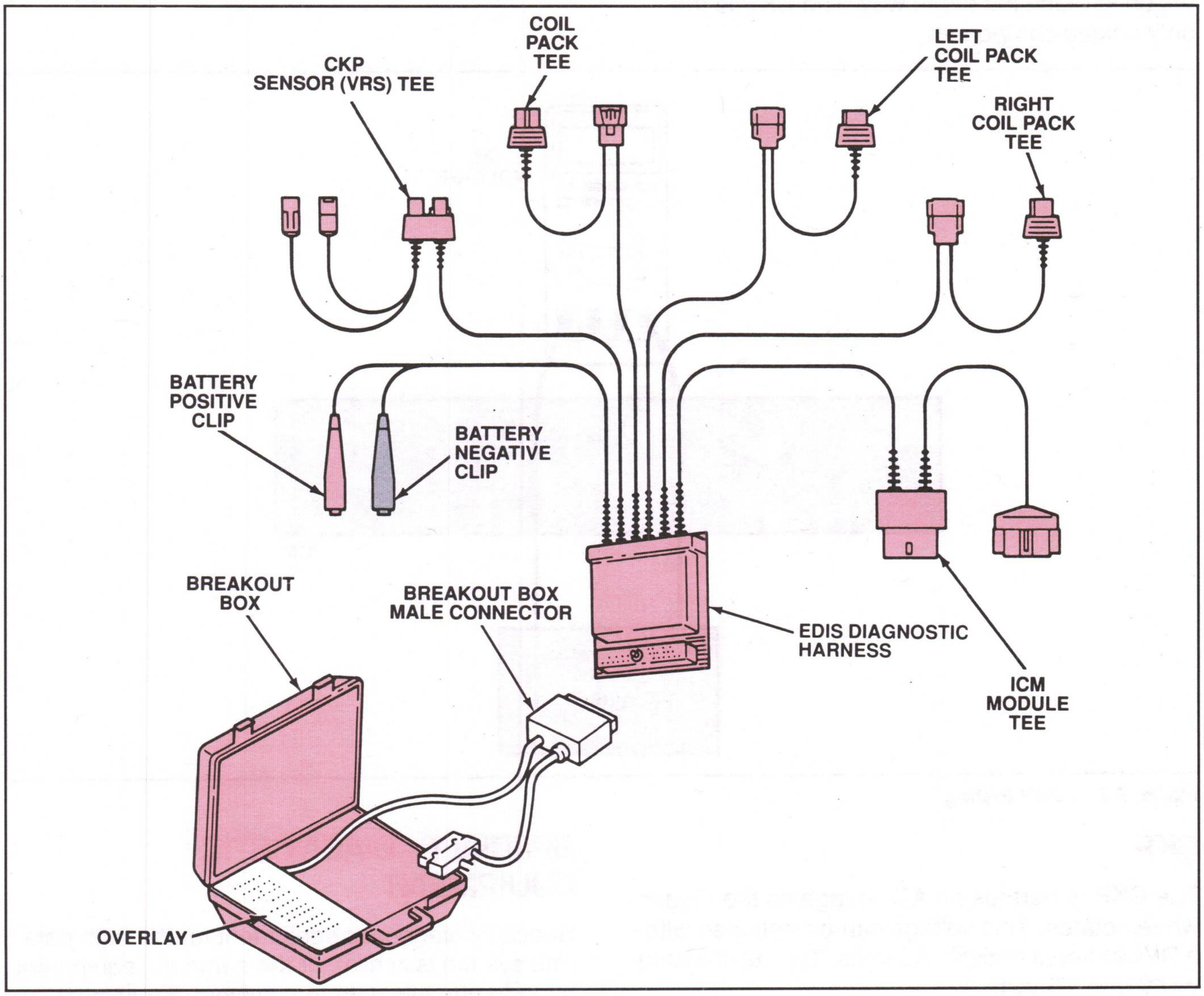


Figure 8-8 — EDIS diagnostic harness and BOB

NOTE: Refer to the "Ignition System Diagnostic Procedures" section in the PCED manual when using this equipment.

Overlays

Overlays are available for use with the BOB. They identify pins for the EI – high data rate system.

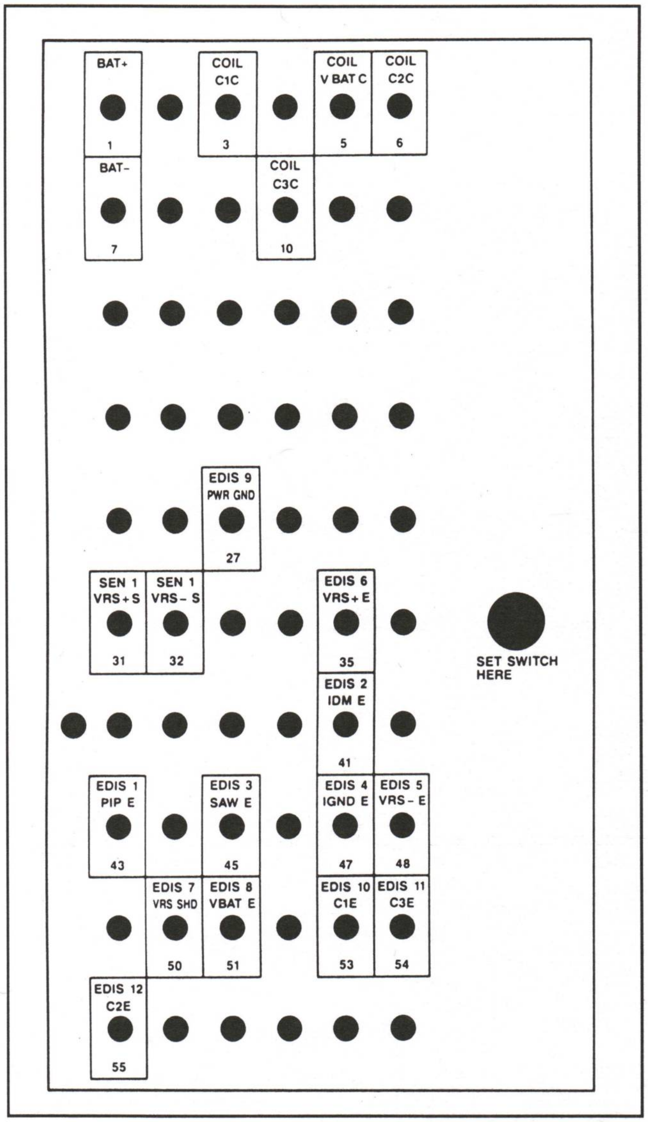


Figure 8-9 — Overlay 4.0L application shown

EI – HIGH DATA RATE REFERENCE MATERIAL

Additional information about the EI – high data rate ignition system can be found in the "Electronic Distributorless Ignition Systems" reference manual. Course number 2301-013.

This is the end of Lesson 8. Now view Lesson 8 on the video tape, and answer the Progress Check questions.

LESSON 8 – PROGRESS CHECK QUESTIONS

The following questions are based on the information contained in Lesson 8. Choose the **ONE** best correct answer. The answers are provided on the following page. Review any questions missed before proceeding to the next lesson.

1. The major difference between low and high data rate EI systems is:

   A. the operating strategy.

   B. the EI system uses higher resistant plug wires than the low data rate system.

   C. the number of CKP sensors used to relay engine speed and position information.

   D. the high data rate system does not need to know piston or crankshaft position.

2. Technician A says the CKP sensor provides information concerning engine speed and piston position. Technician B says when teeth on the trigger wheel pass across the CKP sensor a square wave DC voltage signal is produced. Who is correct?

   A. Technician A

   B. Technician B

   C. Both A and B

   D. Neither A nor B

3. Technician A says that the high data rate system only "fires" cylinders in power pairs when the DPI circuit is grounded. Technician B says the PCM produces a SPOUT signal which the ICM uses to control coil ON and OFF time. Who is correct?

   A. Technician A

   B. Technician B

   C. Both A and B

   D. Neither A nor B

LESSON 8 – PROGRESS CHECK ANSWERS

1. The major difference between low and high data rate EI systems is:

   [✓ A.] the operating strategy.

   B. the EI system uses higher resistant plug wires than the low data rate system.

   C. the number of CKP sensors used to relay engine speed and position information.

   D. the high data rate system does not need to know piston or crankshaft position.

   Engine speed and position information is obtained slightly differently with the high data rate system. As a result, the operating strategies of the PCM and ICM are different.

2. Technician A says the CKP sensor provides information concerning engine speed and piston position. Technician B says when teeth on the trigger wheel pass across the CKP sensor a square wave DC voltage signal is produced. Who is correct?

   [✓ A.] Technician A

   B. Technician B

   C. Both A and B

   D. Neither A nor B

   The trigger wheel and CKP produce a sign wave AC signal that is used to provide engine speed and position information.

3. Technician A says that the high data rate system only “fires” cylinders in power pairs when the DPI circuit is grounded. Technician B says the PCM produces a SPOUT signal which the ICM uses to control coil ON and OFF time. Who is correct?

   A. Technician A

   [✓ B.] Technician B

   C. Both A and B

   D. Neither A nor B

   There is no DPI circuit in high data rate systems. The SPOUT signal does control dwell.

LESSON 8 – PROGRESS CHECK QUESTIONS (CONT'D.)

4. Technician A says overlay cards are only needed when using the BOB. Technician B says that overlay cards are not necessary when using the EEC IV monitor because the circuits and pins are labeled on the monitor. Who is correct?

   A. Technician A

   B. Technician B

   C. Both A and B

   D. Neither A nor B

5. Technician A says that with the engine cranking, a reading of 3.5 volts AC is a normal value produced from a properly operating CKP sensor. Technician B says to measure the CKP voltage you connect a DVOM to the CKP (+) and CKP (-) circuits and select an AC voltage scale. Who is correct?

   A. Technician A

   B. Technician B

   C. Both A and B

   D. Neither A nor B

LESSON 8 – PROGRESS CHECK ANSWERS (CONT'D.)

4. Technician A says overlay cards are only needed when using the BOB. Technician B says that overlay cards are not necessary when using the EEC IV monitor because the circuits and PINS are labeled on the monitor. Who is correct?

   A. Technician A

   B. Technician B

   C. Both A and B

   [✓ D.] Neither A nor B

   Overlays are used with both the EEC IV BOB and EEC IV monitor.

5. Technician A says that with the engine cranking, a reading of 3.5 volts AC is a normal value produced from a properly operating CKP sensor. Technician B says to measure the CKP voltage you connect a DVOM to the CKP (+) and CKP (-) circuits and select an AC voltage scale. Who is correct?

   A. Technician A

   B. Technician B

   [✓ C.] Both A and B

   D. Neither A nor B

   To measure CKP voltage, connect the leads of a DVOM, and set to measure AC volts, to the CKP (+) and (-) circuits. A typical reading, during engine cranking, is 3.5 volts.

IGNITION SYSTEM THEORY AND OPERATION

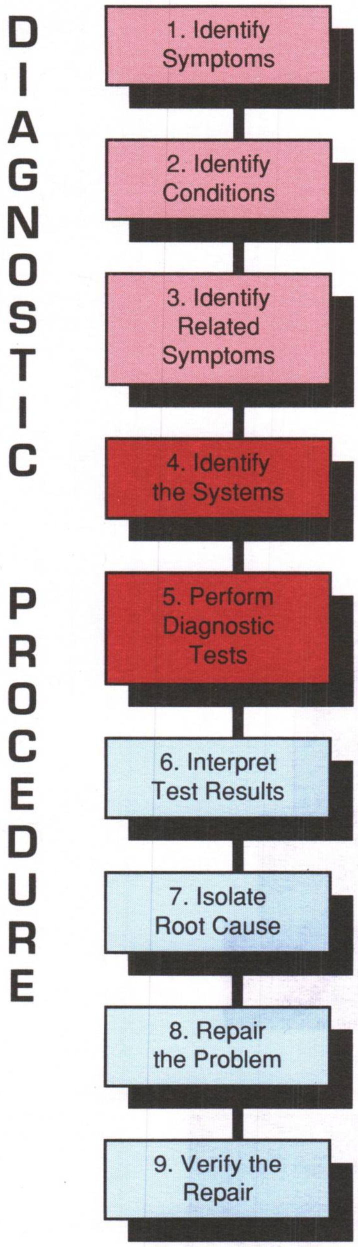
Lesson **1** Spark and Ignition
Lesson **2** Basic Ignition
Lesson **3** Ignition Requirements and Operating Modes
Lesson **4** Ignition Related Driveability Symptoms
Lesson **5** Basic Testing

NAAO

Lesson **6** DI Ignition System
Lesson **7** EI – Low Data Rate Ignition System
Lesson **8** EI – High Data Rate Ignition System
Lesson **9** **EEC System Diagnosis**

ASSOCIATION

Lesson **10** DI Electronically Controlled Timing
Lesson **11** DI Mechanically Controlled Timing
Lesson **12** Villager DI Ignition System



LESSON 9: EEC SYSTEM DIAGNOSIS

The Electronic Engine Control (EEC) system works with several different engine systems. In terms of diagnosis and service the EEC system is an independent or stand alone system. However, in terms of function and operation, the EEC system is really a part of several other systems. The Engine Performance Curriculum treats the EEC system as a part of individual systems. This lesson covers EEC system operation as it pertains to the operation of the ignition system.

The EEC system interacts with the ignition system for the purpose of controlling spark timing. The Powertrain Control Module (PCM) is the “brain” of the EEC system. The PCM receives engine speed, engine load and vehicle speed data from various input sensors. To diagnose symptoms caused by spark timing, an understanding of the relationship between the PCM and input sensors and signals is necessary.

Where does this lesson fit into the diagnostic procedure?

The information in this lesson addresses steps 4 and 5 of the diagnostic procedure. It describes EEC system operation, diagnosis, testing and interpretation of tests.

Objective(s):

The information in this lesson will enable you to:

- Identify and describe the operation of the ignition system components and describe their functions in operating as a system.
- Identify and describe ignition system diagnostic procedures and test equipment.

EEC SYSTEM DIAGNOSIS

EEC INPUTS

The following sensors are used to supply the PCM with input:

- **Mass Air Flow Sensor (MAF)**. The MAF sensor provides engine load data to the PCM.
- **Knock Sensor (KS)**. The KS signals the PCM if spark knock occurs. The PCM will respond by retarding the timing.
- **Crankshaft Position Sensor (CKP)**. The CKP produces a PIP signal. The PIP signal is the primary ignition input signal. It provides the PCM with engine speed and crankshaft position information.
- **Throttle Position Sensor (TPS)**. The TPS provides the PCM with throttle position data. This informs the PCM about engine load and operator demands.
- **Vehicle Speed Sensor (VSS)**. The VSS provides the PCM with vehicle speed data.

NOTE: These are the main inputs that affect ignition timing. The inputs and/or sensors vary between vehicles. The "Engine Supplement" section in the PCED manual contains specific EEC system information for each vehicle.

Currently two versions of EEC systems are used on Ford NAAO vehicles:

- Fourth generation electronic engine control (EEC IV) – 60 pin
- Fifth generation electronic engine control (EEC V) – 104 pin

For ignition purposes both systems perform the same function. However, the diagnostic and testing procedures are different for each system.

This lesson will cover the resources, tests and test equipment used to evaluate EEC system operation and diagnose EEC concerns. EEC IV and EEC V systems will be covered separately.

EEC IV DIAGNOSTIC RESOURCES

The following resources contain EEC IV related diagnostic and service information:

- **Powertrain Control/Emissions Diagnosis (PCED) manual**
- **Electrical Vacuum Troubleshooting Manual (EVTM)**
- **Technical Service Bulletins (TSBs)**
- **Shop manuals**
- **On-Line Automotive Service Information System (OASIS)**

PCED Manual

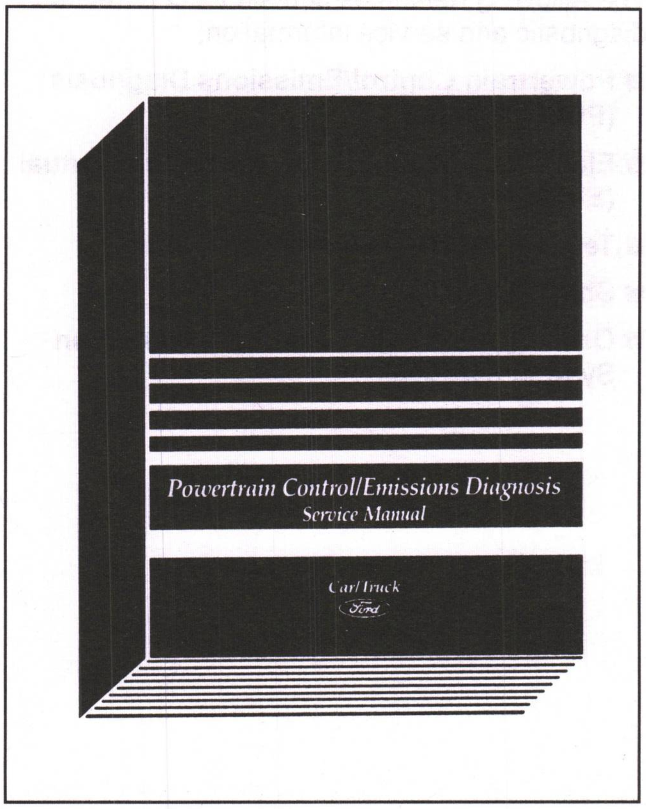


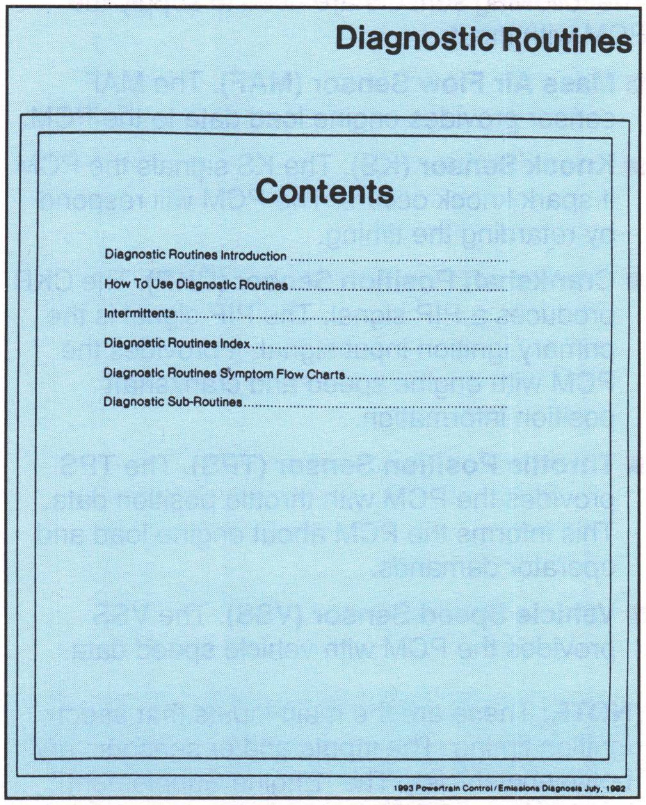
Figure 9-1 — PCED manual

The Powertrain Control Emissions Diagnosis (PCED) manual contains EEC system operation and diagnostic information. This information is divided into the following sections:

- Ignition System Diagnostic Procedures
- Diagnostic Routines
- EEC IV Engine Supplement — Car
- EEC IV Engine Supplement — Truck
- EEC IV Quick Test Procedures
- EEC IV Pinpoint Test Procedures
- EEC IV Intermittent Fault Diagnosis

NOTE: All NAAO EEC material is found in the "A" sections of the PCED manual.

DIAGNOSTIC ROUTINES



Diagnostic Routines

Contents

Diagnostic Routines Introduction ....
How To Use Diagnostic Routines ....
Intermittents..........
Diagnostic Routines Index..........
Diagnostic Routines Symptom Flow Charts..........
Diagnostic Sub-Routines..........

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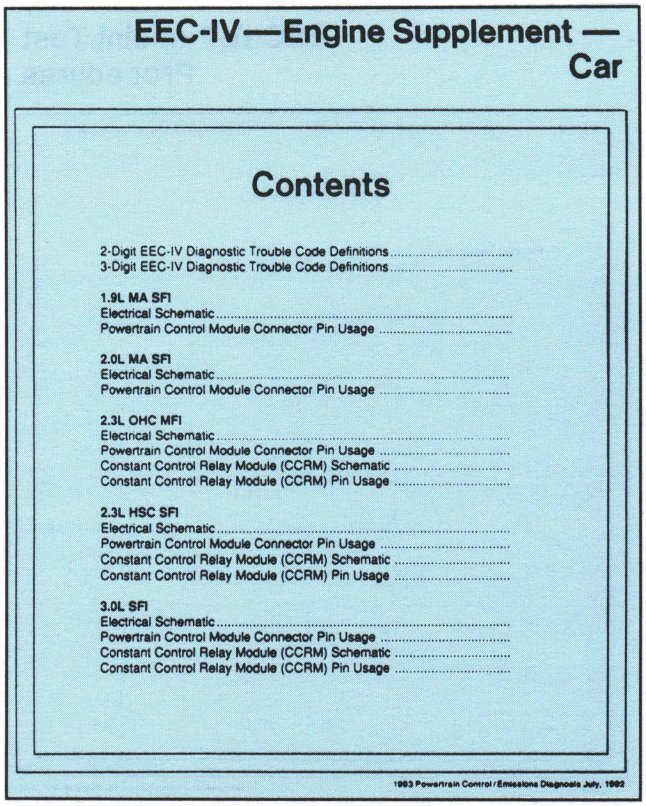
Figure 9-2 — PCED diagnostic routines

The "Ignition System Diagnostic Procedures" section of the PCED manual contains descriptions of the different ignition systems used on Ford, Lincoln and Mercury vehicles. It also contains diagnostic and Pinpoint Tests (PPTs) for the various ignition systems.

The "Diagnostic Routines" section of the PCED manual is designed to provide diagnostic direction. It contains a symptom-based diagnostic routine flow chart, diagnostic subroutines and Diagnostic Trouble Code (DTC) charts.

When using the PCED to diagnose driveability concerns you should begin in the "Diagnostic Routines" section.

EEC IV ENGINE SUPPLEMENTS



EEC-IV—Engine Supplement —
Car

Contents

2-Digit EEC-IV Diagnostic Trouble Code Definitions ....
3-Digit EEC-IV Diagnostic Trouble Code Definitions ....

1.9L MA SFI
Electrical Schematic ....
Powertrain Control Module Connector Pin Usage ....

2.0L MA SFI
Electrical Schematic ....
Powertrain Control Module Connector Pin Usage ....

2.3L OHC MFI
Electrical Schematic ....
Powertrain Control Module Connector Pin Usage ....
Constant Control Relay Module (CCRM) Schematic ....
Constant Control Relay Module (CCRM) Pin Usage ....

2.3L HSC SFI
Electrical Schematic ....
Powertrain Control Module Connector Pin Usage ....
Constant Control Relay Module (CCRM) Schematic ....
Constant Control Relay Module (CCRM) Pin Usage ....

3.0L SFI
Electrical Schematic ....
Powertrain Control Module Connector Pin Usage ....
Constant Control Relay Module (CCRM) Schematic ....
Constant Control Relay Module (CCRM) Pin Usage ....

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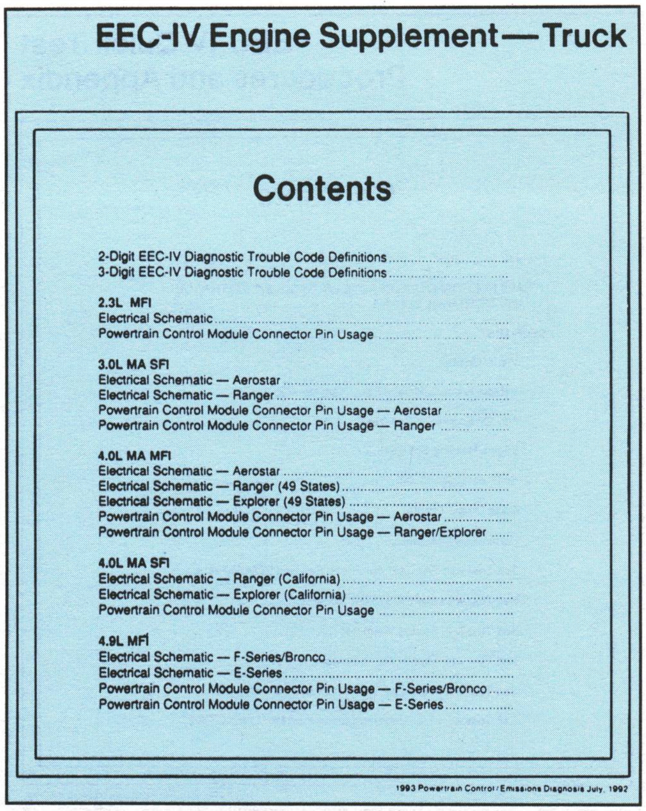
Figure 9-3 — PCED Supplement — Car

There are two "EEC Engine Supplement" sections: one each for cars and trucks. These sections contain EEC schematics, Powertrain Control Module (PCM) pin identification and DTC definition charts for each vehicle and powertrain.



EEC-IV Engine Supplement—Truck

Contents

2-Digit EEC-IV Diagnostic Trouble Code Definitions ....
3-Digit EEC-IV Diagnostic Trouble Code Definitions ....

2.3L MFI
Electrical Schematic ....
Powertrain Control Module Connector Pin Usage ....

3.0L MA SFI
Electrical Schematic — Aerostar ....
Electrical Schematic — Ranger ....
Powertrain Control Module Connector Pin Usage — Aerostar ....
Powertrain Control Module Connector Pin Usage — Ranger ....

4.0L MA MFI
Electrical Schematic — Aerostar ....
Electrical Schematic — Ranger (49 States) ....
Electrical Schematic — Explorer (49 States) ....
Powertrain Control Module Connector Pin Usage — Aerostar ....
Powertrain Control Module Connector Pin Usage — Ranger/Explorer ....

4.0L MA SFI
Electrical Schematic — Ranger (California) ....
Electrical Schematic — Explorer (California) ....
Powertrain Control Module Connector Pin Usage ....

4.9L MFI
Electrical Schematic — F-Series/Bronco ....
Electrical Schematic — E-Series ....
Powertrain Control Module Connector Pin Usage — F-Series/Bronco ....
Powertrain Control Module Connector Pin Usage — E-Series ....

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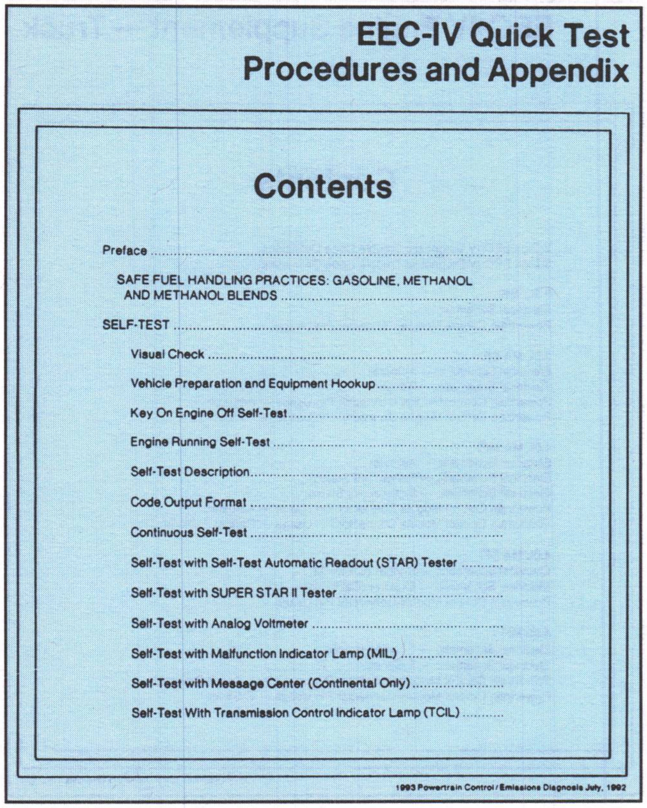
Figure 9-4 — PCED Supplement — Truck

EEC IV QUICK TEST PROCEDURES



EEC-IV Quick Test Procedures and Appendix

Contents

Preface

SAFE FUEL HANDLING PRACTICES: GASOLINE, METHANOL AND METHANOL BLENDS

SELF-TEST

- Visual Check
- Vehicle Preparation and Equipment Hookup
- Key On Engine Off Self-Test
- Engine Running Self-Test
- Self-Test Description
- Code Output Format
- Continuous Self-Test
- Self-Test with Self-Test Automatic Readout (STAR) Tester
- Self-Test with SUPER STAR II Tester
- Self-Test with Analog Voltmeter
- Self-Test with Malfunction Indicator Lamp (MIL)
- Self-Test with Message Center (Continental Only)
- Self-Test With Transmission Control Indicator Lamp (TCIL)

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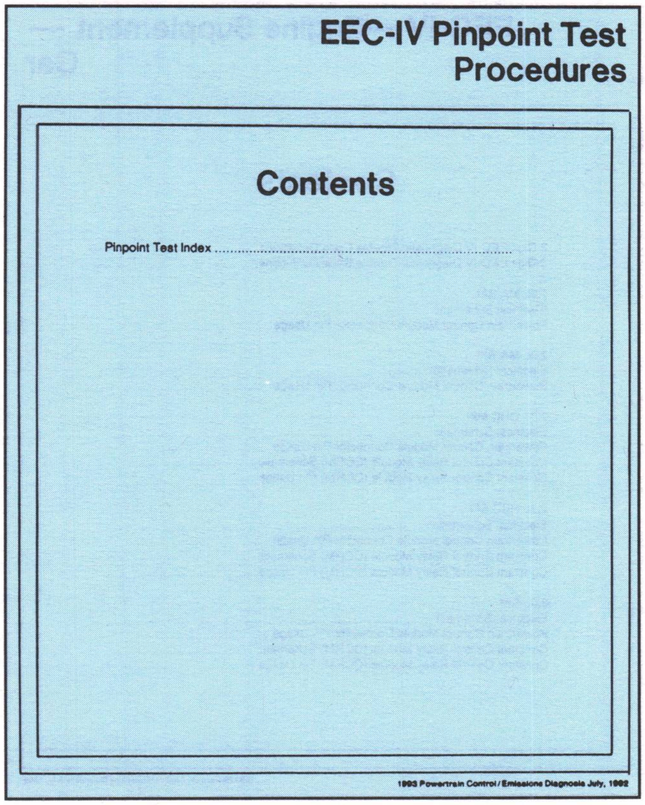
Figure 9-5 — Quick Test Procedures

The "Quick Test Procedures" section contains information pertaining to quick test procedures, diagnostic aid test procedures and the test equipment used to perform these tests.

EEC IV PINPOINT TEST PROCEDURES



EEC-IV Pinpoint Test Procedures

Contents

Pinpoint Test Index

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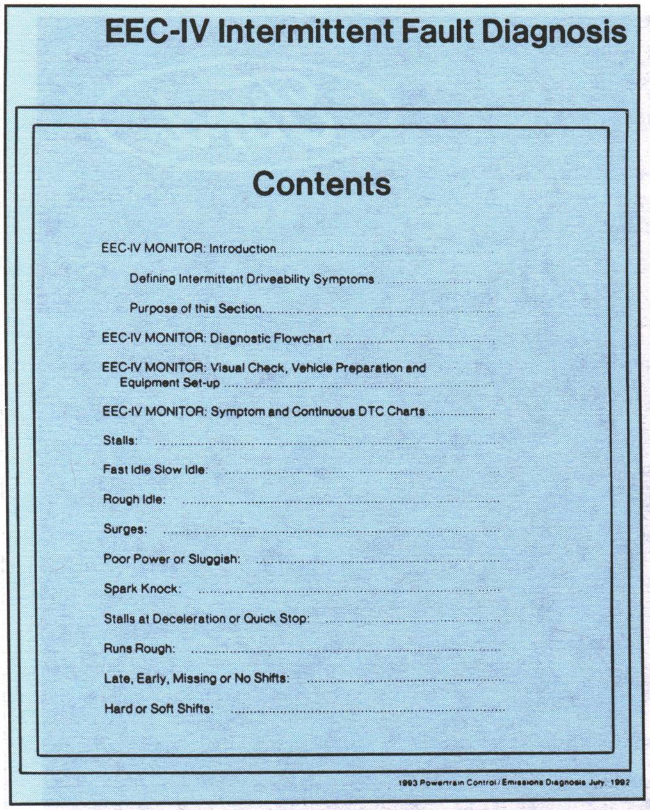
Figure 9-6 — Pinpoint Test Procedures

Pinpoint Tests (PPTs) provide step by step instructions designed to isolate specific concerns. Only perform PPTs when directed to do so by the PCED manual.

EEC IV INTERMITTENT FAULT DIAGNOSIS



EEC-IV Intermittent Fault Diagnosis

Contents

EEC-IV MONITOR: Introduction ....

  Defining Intermittent Driveability Symptoms ....

  Purpose of this Section ....

EEC-IV MONITOR: Diagnostic Flowchart ....

EEC-IV MONITOR: Visual Check, Vehicle Preparation and Equipment Set-up ....

EEC-IV MONITOR: Symptom and Continuous DTC Charts ....

Stalls: ....

Fast Idle Slow Idle: ....

Rough Idle: ....

Surges: ....

Poor Power or Sluggish: ....

Spark Knock: ....

Stalls at Deceleration or Quick Stop: ....

Runs Rough: ....

Late, Early, Missing or No Shifts: ....

Hard or Soft Shifts: ....

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Figure 9-7 — Intermittent Fault Diagnosis

This section provides direction when diagnosing intermittent concerns. It contains symptom charts and diagnostic reference value charts.

EVTMs

Ford

Mustang

Electrical & Vacuum Troubleshooting Manual

Figure 9-8 — Mustang EVTM

Electrical Vacuum Troubleshooting Manuals (EVTMs) contain electrical schematics, system operation overviews and component location indexes.

TSBs

Figure 9-9 — Technical service bulletin

Technical Service Bulletins (TSBs) contain specific diagnostic and service information. The information and procedures provided by TSBs can help reduce diagnostic and service times.

Shop Manuals

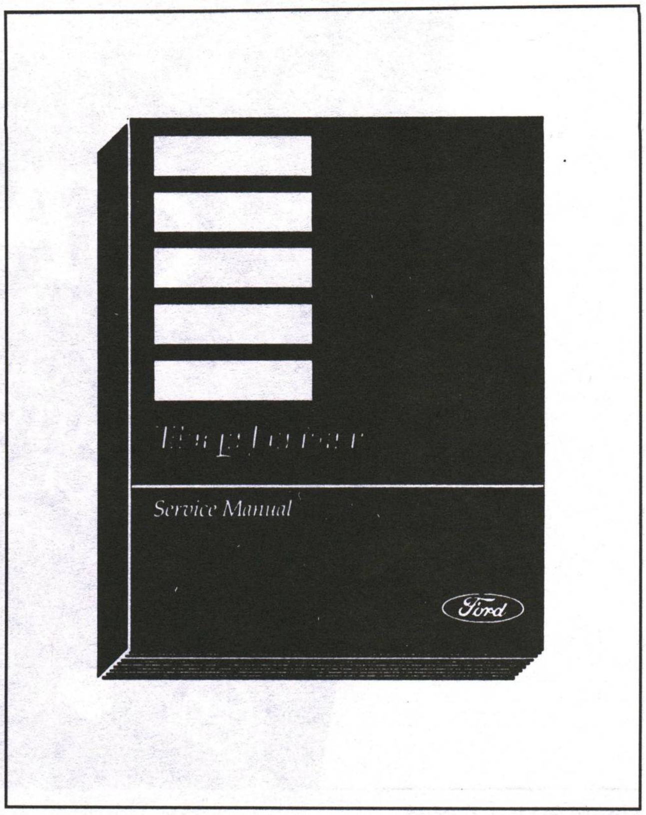


Figure 9-10 — Explorer shop manual

Each vehicle, or vehicle family, has a shop manual devoted to it. Shop manuals contain system operation information and servicing procedures.

OASIS

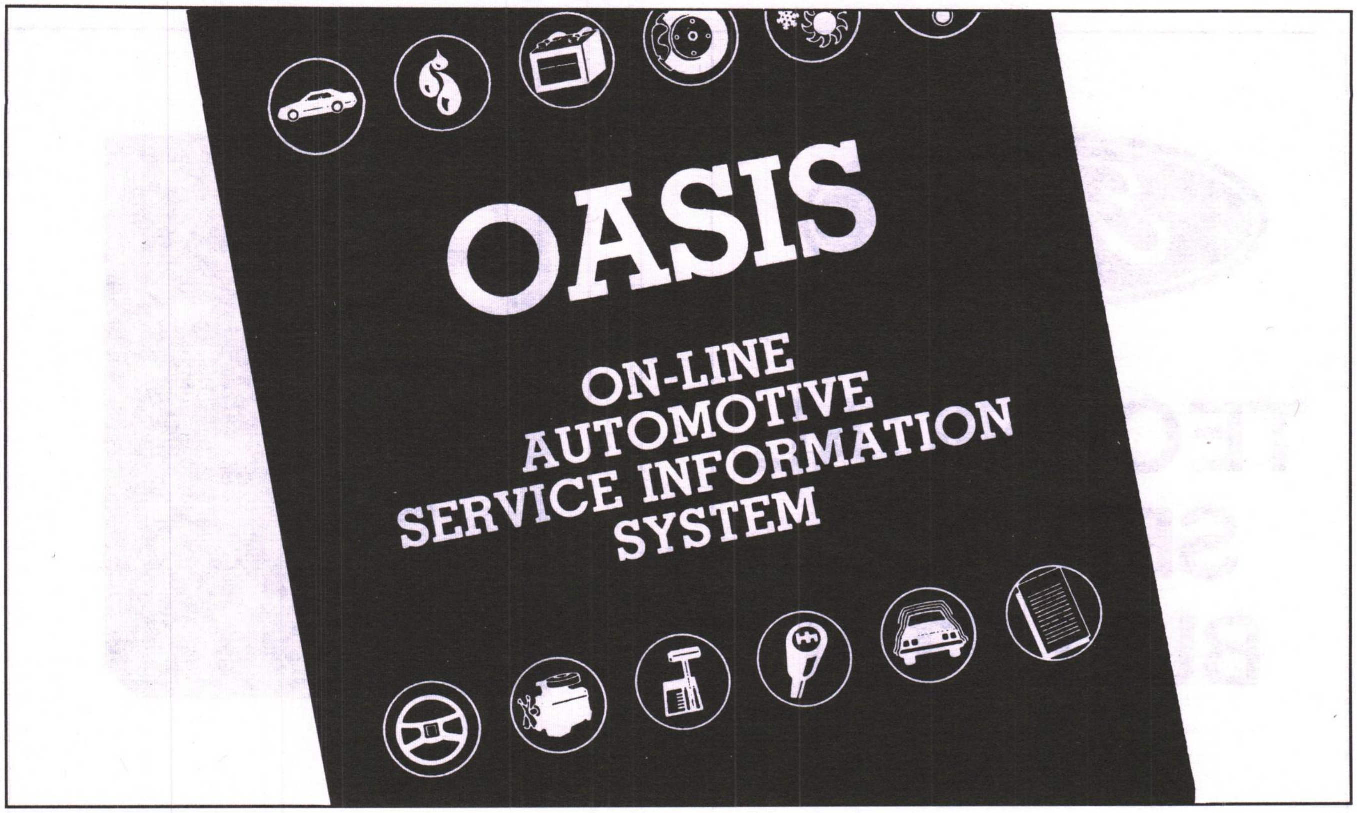


Figure 9-11 — OASIS

The On-Line Automotive Service Information System (OASIS) network contains service messages and TSB references. You should consult OASIS on every job and enter a symptom code appropriate for the concern you are servicing. The OASIS network can provide specific diagnostic and service information that can reduce diagnostic and repair time.

EEC IV DIAGNOSIS

The following tests are performed with the EEC IV system:

- Quick Test
- Continuous diagnostic test mode (wiggle test)
- Output state diagnostic test mode
- Cylinder balance diagnostic test mode
- EEC IV pinpoint tests
- Timing tests
- EEC system monitoring tests

EEC IV Quick Test

Quick tests take advantage of the PCM's self diagnostic capabilities. The PCM monitors the operation of input and output devices. If open circuit, short circuit, inoperative or out of range conditions are detected, the PCM sets a **Diagnostic Trouble Code (DTC)**. Quick test procedures are used to retrieve DTCs from the PCM.

Quick tests are divided into three individual tests called "Self Tests".

- **Key On, Engine Off (KOEO) Self Test**
- Continuous self test
- **Key On, Engine Running (KOER) Self Test**

EEC IV KOEO SELF TEST

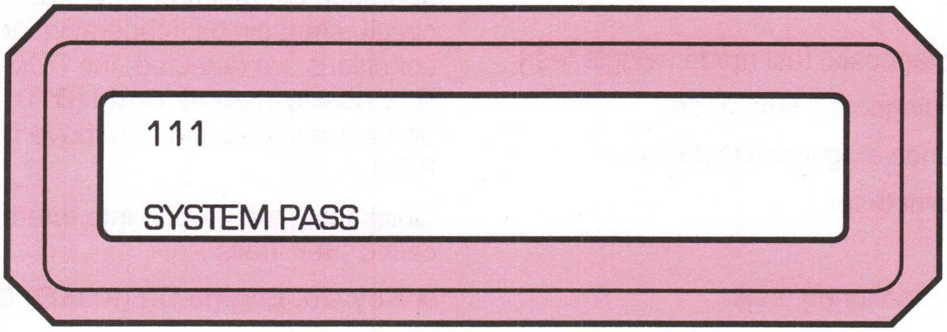


Figure 9-12 — EEC IV system pass code on tester readout screen

When the Key On, Engine Off (KOEO) self test is initiated, the PCM enters an interactive test mode. In this test mode, the PCM activates various components and looks for responses or state changes. If it does not see the correct responses or state changes it sets a DTC. During KOEO and KOER self tests, certain inputs are also checked for proper range.

When a DTC is set during a KOEO self test, a fault occurred at the time of testing. This is known as a "hard fault."

When a DTC is received during a self test, a PPT should be performed, as directed by the PCED manual. The PPT is designed to determine why the DTC exists. If no faults are detected, a passing three-digit code, 111, is issued.

NOTE: Most EEC IV DTCs are three digits. However, some older EEC IV systems output two-digit DTCs. Refer to the PCED manual for the vehicle being serviced.

EEC IV CONTINUOUS SELF TEST

The continuous self test is a function of the PCM's self diagnostic capability. This test is conducted while the vehicle is operated. Faults that occur intermittently or only during vehicle operation are stored in the PCM's **Keep Alive Memory (KAM)**. A DTC will remain stored in KAM for up to 80 warm-up cycles (40 cycles on some applications).

Continuous DTCs (also called "memory" DTCs) are retrieved after KOEO self test codes and a separator code have been displayed. Continuous DTCs are three-digit, and a DTC 111 means system pass.

EEC IV KOER SELF TEST

When a Key On, Engine Running KOER self test is performed, the PCM enters an interactive test mode, similar to the KOEO self test. The PCM activates various devices and looks for the proper responses. DTCs received during a KOER self test are hard faults.

EEC IV QUICK TEST EQUIPMENT

NGS

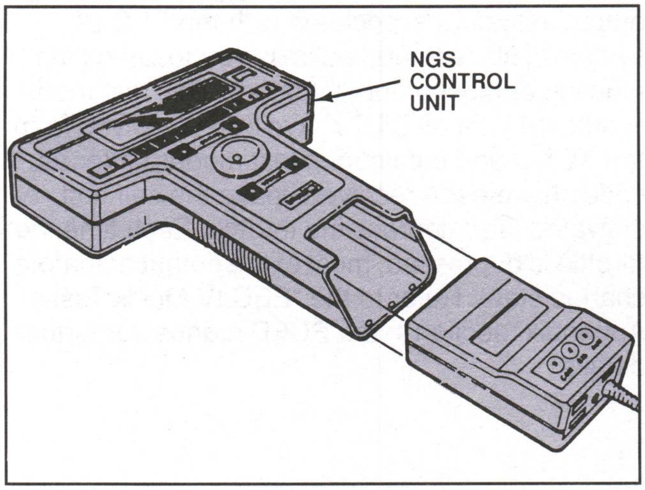


Figure 9-13 — NGS

The **New Generation STAR (NGS)** is the primary tool used to perform the various self tests which make up the quick test procedure.

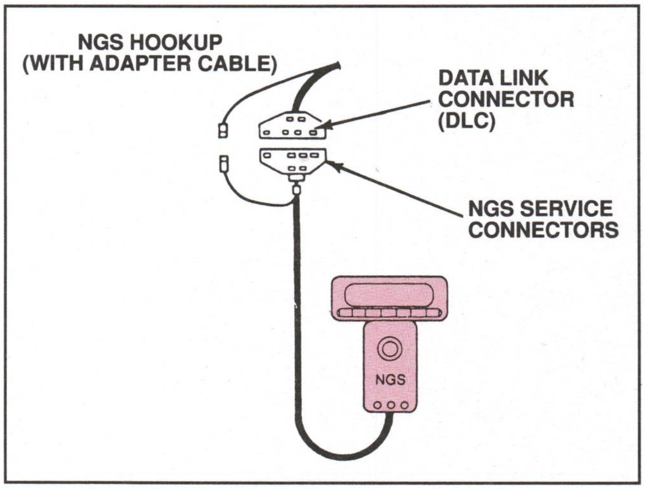


Figure 9-14 — NGS hook-up

The NGS is connected to the PCM through the **Data Link Connector (DLC)**. Refer to the "EEC IV Quick Test Procedures" section in the PCED manual for further details.

Super STAR II

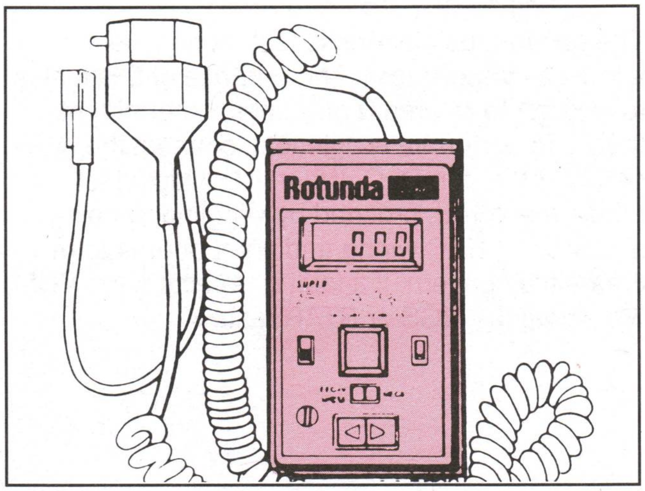


Figure 9-15 — Super STAR II

The **Super STAR II tester** can be used to retrieve DTCs from EEC IV systems. Refer to the "EEC IV Quick Test Appendix" section in the PCED manual for further details.

MIL

The Malfunction Indicator Light (MIL) will give the DTCs on some EEC IV systems. Follow the procedure in the "EEC IV Quick Test Appendix" of the PCED manual for instructions.

EEC IV Continuous Diagnostic Test Mode (Wiggle Test)

The continuous diagnostic test mode is also known as **wiggle test**. The purpose of this test is to attempt to re-create and detect intermittent faults. To perform a wiggle test, connect the NGS or STAR II to the DLC. When the wiggle test mode is entered, proceed by wiggling, tapping and moving EEC wiring and components to re-create the concern. If a fault is detected, the PCM will signal the NGS or STAR tester.

EEC IV Output State Diagnostic Test Mode

The output state test mode aids you in servicing output actuators associated with the EEC IV system. This test mode allows you to check the function of most of the actuators. This test mode is entered after all DTCs have been received from the KOEO and continuous test modes. After all codes have been received, leave the self test activated, and depress the throttle. Each time the throttle is depressed, most of the output actuators change state. Refer to the "EEC IV Quick Test Appendix" section in the PCED manual for further details.

EEC IV Cylinder Balance Diagnostic Test Mode

POSSIBLE CODE OUTPUTS
(Code 30 indicates cylinder number 3. Code 30 is used as an example only)

LEVEL			INDICATION
1	2	3	
90	X	X	Indicates a pass, all cylinders contributing equally.
30	90	X	Indicates a weak cylinder. Cylinder is firing, but not contributing as much as the others.
30	30	90	Same as above, but more severe.
30	30	30	Very weak or dead cylinder.

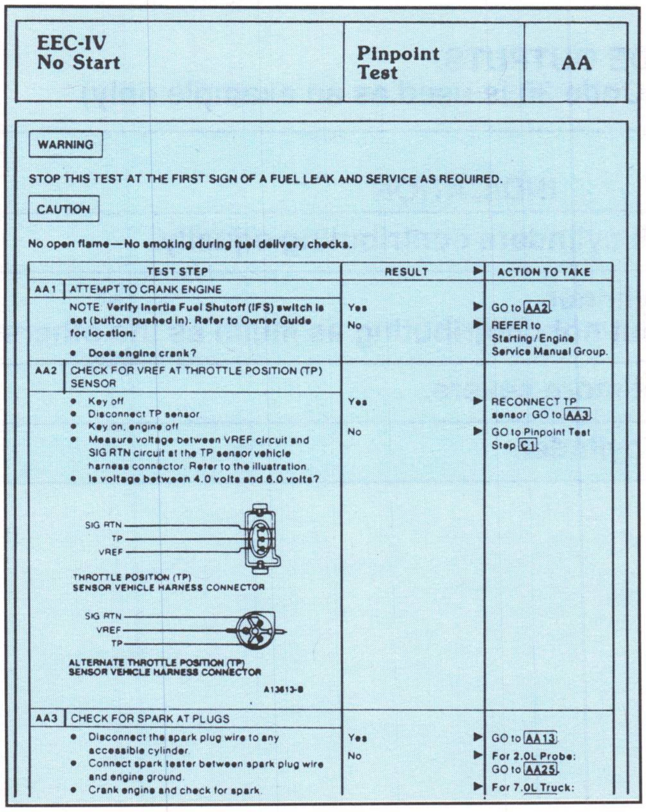
X = no further testing necessary

Figure 9-16 — Cylinder balance test results

The **Cylinder Balance Test** can only be performed on vehicles with **Sequential Fuel Injection (SFI)** systems. The purpose of this test is to identify weak or non-contributing cylinders. To enter this test, leave the PCM in the KOER self test mode. Depress the throttle within two minutes after the last KOER DTC has been received. Once the test is entered, fuel is shut off to individual cylinders. The PCM can identify weak or non-contributing cylinders by comparing the RPM drop as the fuel to each cylinder is shut off.

If the PCM identifies a cylinder that is weak or non-contributing, it will set a code which is displayed on the NGS or STAR II. The test can be repeated two additional times. Performing the test again helps identify the level of cylinder weakness or contribution. Refer to the "EEC IV Quick Test Procedures" section in the PCED manual for more details.

EEC IV PPT



EEC-IV No Start	Pinpoint Test	AA

WARNING

STOP THIS TEST AT THE FIRST SIGN OF A FUEL LEAK AND SERVICE AS REQUIRED.

CAUTION

No open flame—No smoking during fuel delivery checks.

	TEST STEP	RESULT ▶	ACTION TO TAKE
AA1	ATTEMPT TO CRANK ENGINE		
	NOTE: **Verify Inertia Fuel Shutoff (IFS) switch is set (button pushed in). Refer to Owner Guide for location.** • **Does engine crank?**	Yes ▶ No ▶	GO to AA2. REFER to Starting/Engine Service Manual Group.
AA2	CHECK FOR VREF AT THROTTLE POSITION (TP) SENSOR		
	• Key off • Disconnect TP sensor. • Key on, engine off • Measure voltage between VREF circuit and SIG RTN circuit at the TP sensor vehicle harness connector. Refer to the illustration. • **Is voltage between 4.0 volts and 6.0 volts?** SIG RTN TP VREF THROTTLE POSITION (TP) SENSOR VEHICLE HARNESS CONNECTOR SIG RTN VREF TP ALTERNATE THROTTLE POSITION (TP) SENSOR VEHICLE HARNESS CONNECTOR A13613-B	Yes ▶ No ▶	RECONNECT TP sensor. GO to AA3. GO to Pinpoint Test Step C1.
AA3	CHECK FOR SPARK AT PLUGS		
	• Disconnect the spark plug wire to any accessible cylinder. • Connect spark tester between spark plug wire and engine ground. • Crank engine and check for spark.	Yes ▶ No ▶ ▶	GO to AA13. For 2.0L Probe: GO to AA25. For 7.0L Truck:

Figure 9-17 — No start PPT

PPTs are step by step instructions designed to isolate specific concerns. You should perform PPTs only when instructed to do so by the PCED manual.

EEC IV Timing Tests

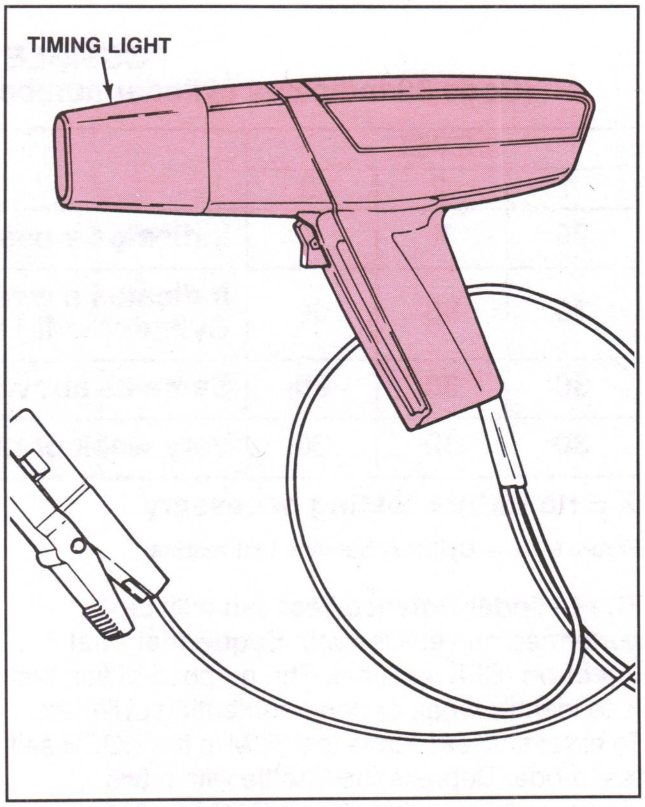


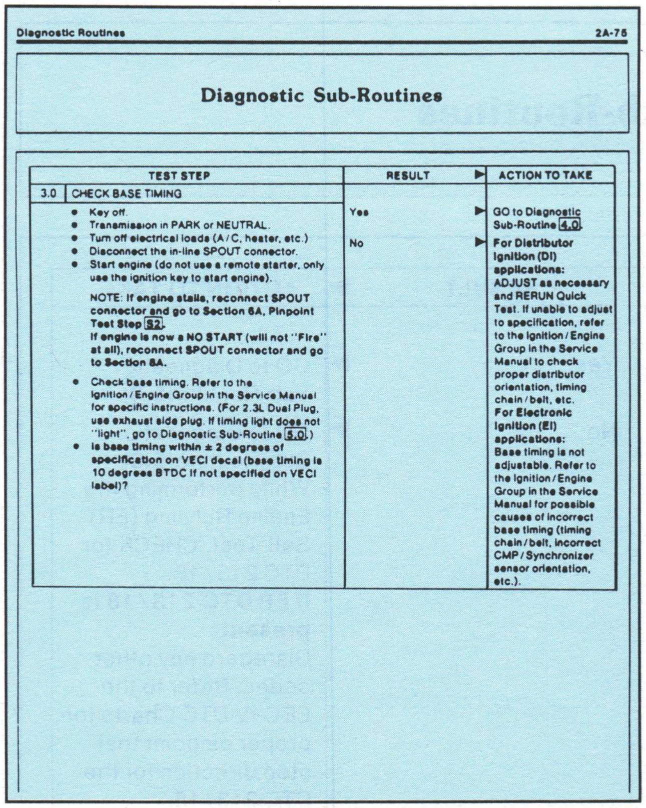
Figure 9-18 — Timing light

Two timing tests can be performed on EEC IV systems:

- Base timing
- Computed timing

An inductive timing light is used to perform these timing tests.

BASE TIMING



Diagnostic Routines 2A-75

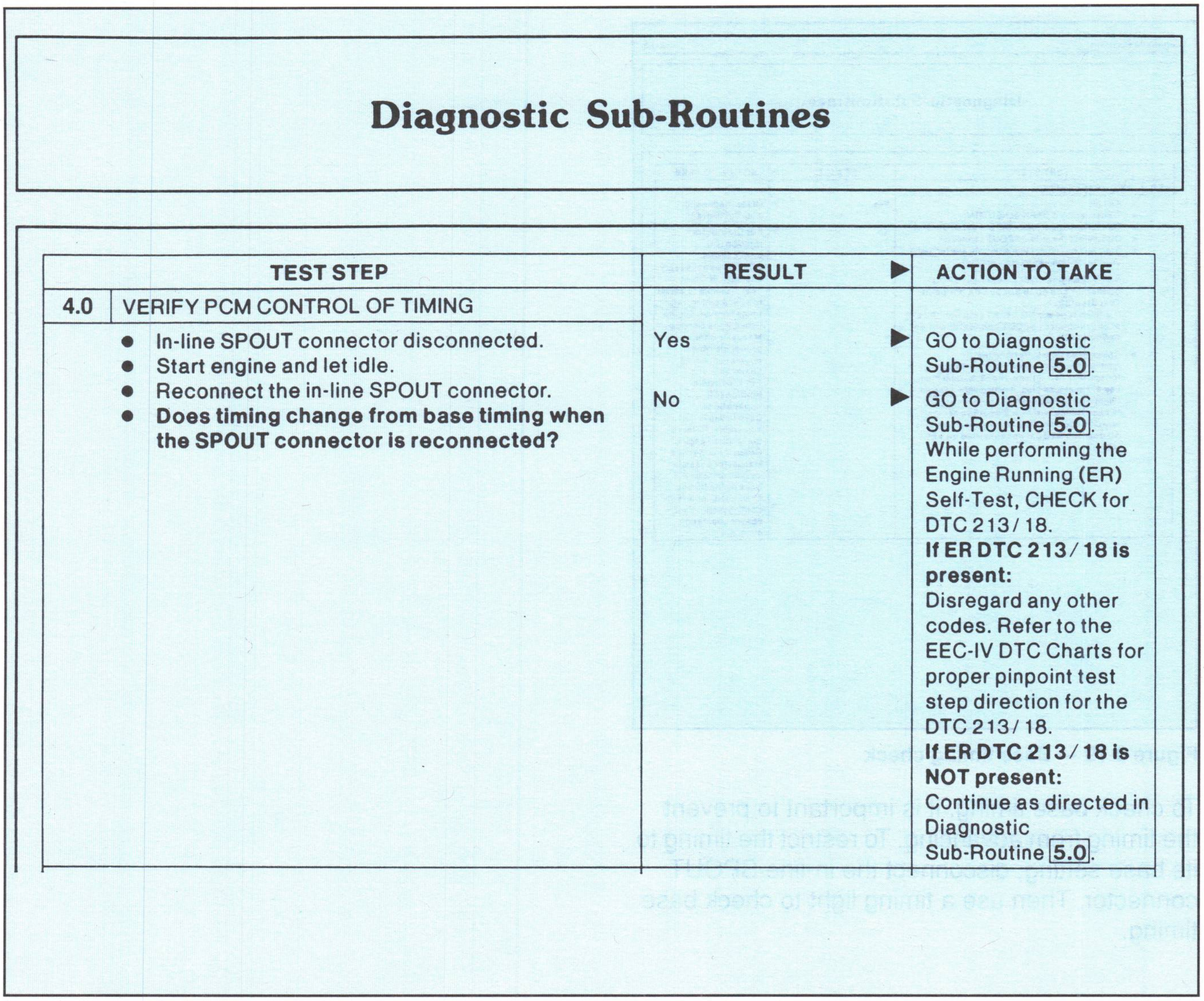
Diagnostic Sub-Routines

	TEST STEP	RESULT ▶	ACTION TO TAKE
3.0	CHECK BASE TIMING		
	• Key off. • Transmission in PARK or NEUTRAL. • Turn off electrical loads (A/C, heater, etc.) • Disconnect the in-line SPOUT connector. • Start engine (do not use a remote starter, only use the ignition key to start engine). **NOTE: If engine stalls, reconnect SPOUT connector and go to Section 6A, Pinpoint Test Step S2.** **If engine is now a NO START (will not "Fire" at all), reconnect SPOUT connector and go to Section 8A.** • Check base timing. Refer to the Ignition/Engine Group in the Service Manual for specific instructions. (For 2.3L Dual Plug, use exhaust side plug. If timing light does not "light", go to Diagnostic Sub-Routine 5.0.) • **Is base timing within ± 2 degrees of specification on VECI decal (base timing is 10 degrees BTDC if not specified on VECI label)?**	Yes ▶	GO to Diagnostic Sub-Routine 4.0.
		No ▶	**For Distributor Ignition (DI) applications:** ADJUST as necessary and RERUN Quick Test. If unable to adjust to specification, refer to the Ignition/Engine Group in the Service Manual to check proper distributor orientation, timing chain/belt, etc. **For Electronic Ignition (EI) applications:** Base timing is not adjustable. Refer to the Ignition/Engine Group in the Service Manual for possible causes of incorrect base timing (timing chain/belt, incorrect CMP/Synchronizer sensor orientation, etc.).

Figure 9-19 — Base timing check

To check base timing, it is important to prevent the timing from advancing. To restrict the timing to its base setting, disconnect the in-line SPOUT connector. Then use a timing light to check base timing.

COMPUTED TIMING



Diagnostic Sub-Routines

TEST STEP		RESULT	▶ ACTION TO TAKE
4.0	VERIFY PCM CONTROL OF TIMING		
	• In-line SPOUT connector disconnected. • Start engine and let idle. • Reconnect the in-line SPOUT connector. • **Does timing change from base timing when the SPOUT connector is reconnected?**	Yes	▶ GO to Diagnostic Sub-Routine $\boxed{5.0}$.
		No	▶ GO to Diagnostic Sub-Routine $\boxed{5.0}$. While performing the Engine Running (ER) Self-Test, CHECK for DTC 213/18. **If ER DTC 213/18 is present:** Disregard any other codes. Refer to the EEC-IV DTC Charts for proper pinpoint test step direction for the DTC 213/18. **If ER DTC 213/18 is NOT present:** Continue as directed in Diagnostic Sub-Routine $\boxed{5.0}$.

Figure 9-20 — Computed timing check

After confirming that the base timing is correct, reconnect the in-line SPOUT connector. Use the timing light to check for timing advance and to verify that the PCM is controlling timing

NOTE: Some EEC IV systems have a computed timing check which is performed as a part of the KOER self test. Always refer to the PCED manual for the vehicle being serviced and follow the directions given.

EEC IV System Monitoring

EEC monitoring tests are performed to isolate intermittent faults or faults that only occur during specific operating modes.

The following tools are used to perform these tests:

- New Generation STAR (NGS) tester
- EEC IV monitor and recorder
- EEC IV Breakout Box (BOB)
- Digital Volt Ohm Meter (DVOM)
- Service Bay Diagnostic System (SBDS)

NGS

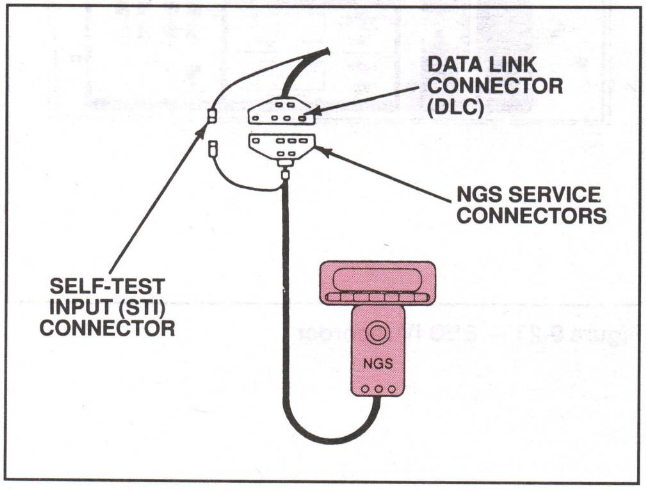


Figure 9-21 — NGS tester

Some EEC IV systems have a data stream link. The NGS can be used as a scan tool on EEC IV vehicles that have a data stream. With the NGS connected to the DLC operate the vehicle and monitor various PCM circuits or systems. Refer to the “EEC IV Intermittent Fault Diagnosis” section in the PCED manual.

EEC IV MONITOR AND RECORDER

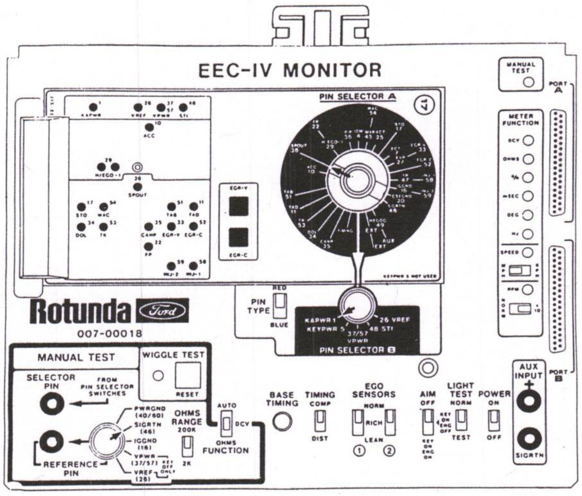


Figure 9-22 — EEC IV monitor

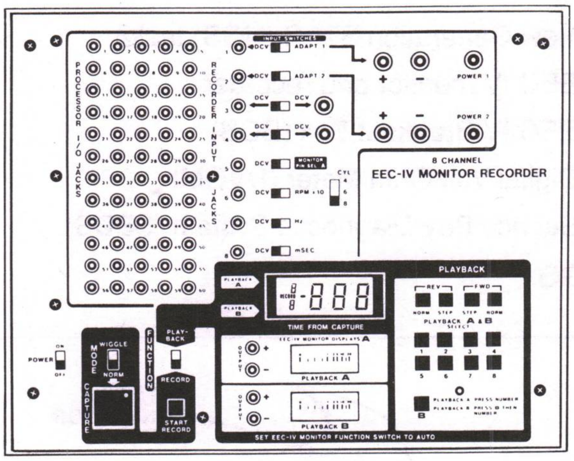


Figure 9-23 — EEC IV recorder

The EEC IV monitor connects to the PCM. When connected, the vehicle can be operated and various PCM functions monitored. Overlay cards, specific to the vehicle being serviced, are provided and must be used correctly. An EEC IV recorder is also available. The recorder connects to the monitor and allows you to record up to eight channels of data. Refer to the "EEC IV Intermittent Fault Diagnosis" section in the PCED manual and/or the EEC IV Monitor manual when performing monitor tests.

EEC IV BOB AND DVOM

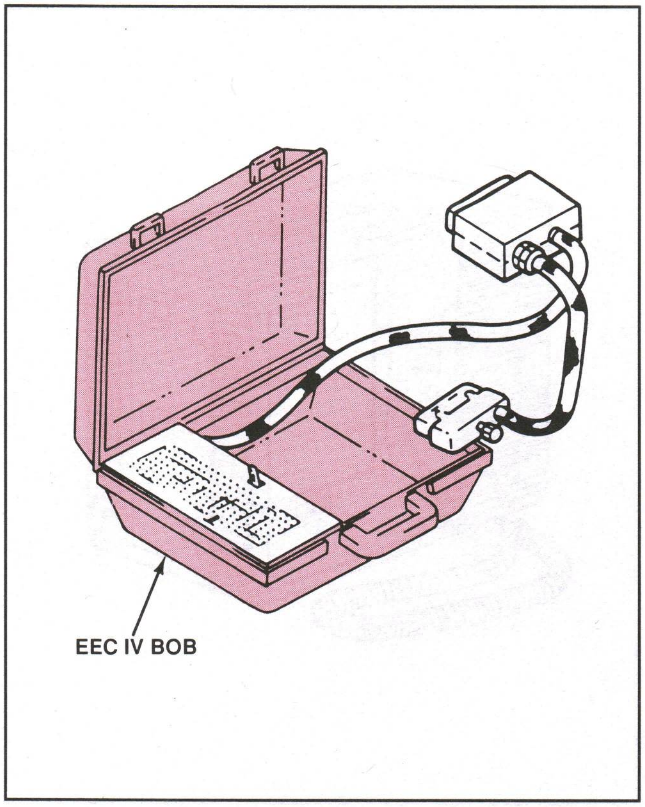


Figure 9-24 — EEC IV BOB

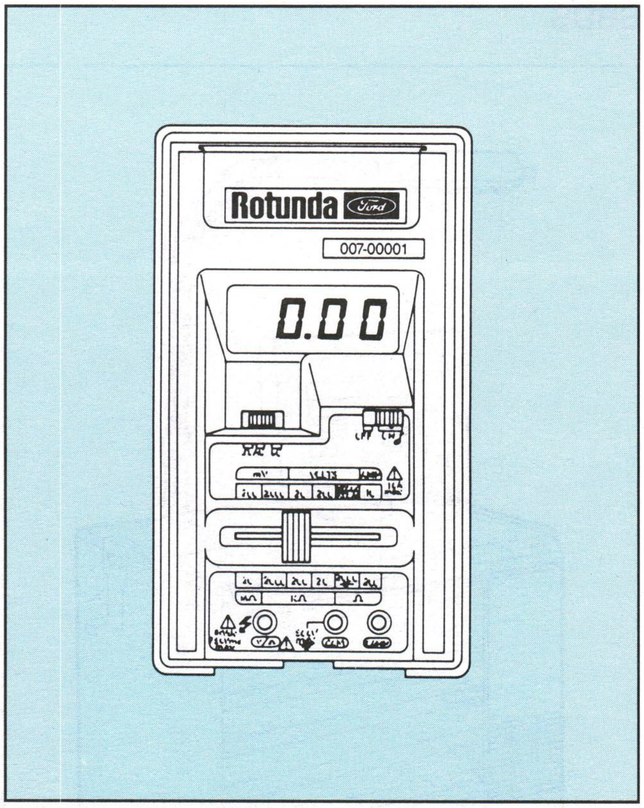


Figure 9-25 — DVOM

The EEC IV BOB and Digital Volt Ohm Meter (DVOM) can be used to monitor various EEC circuits while operating the vehicle. Refer to the “EEC IV Intermittent Diagnosis” section in the PCED manual when performing EEC system monitoring diagnostics.

SBDS

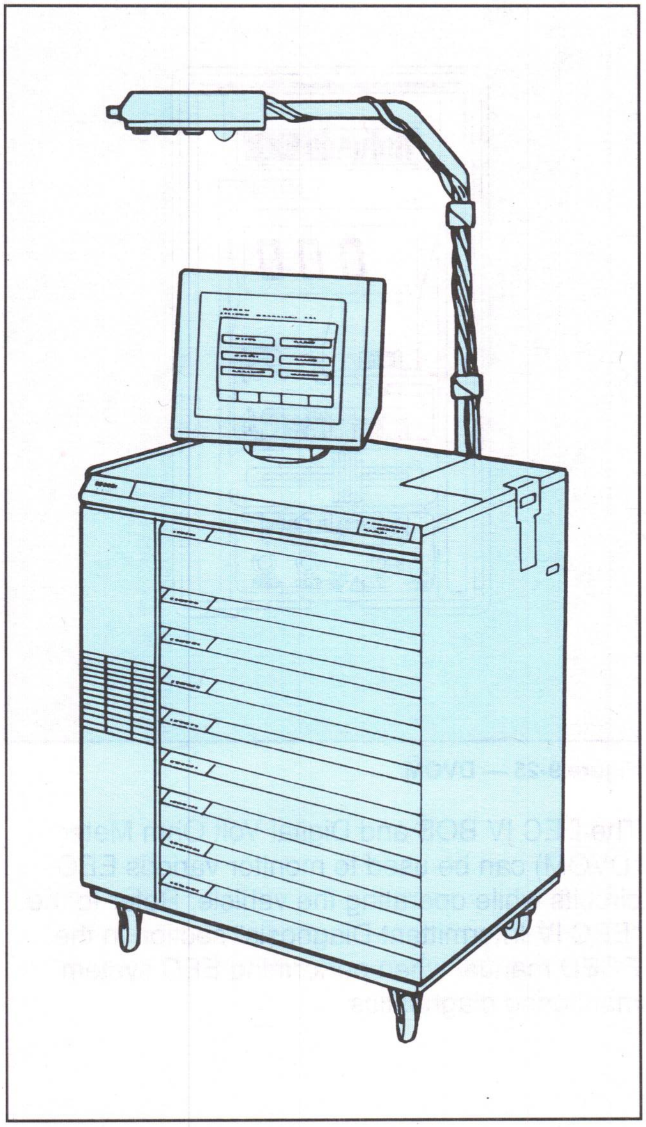


Figure 9-26 — SBDS

The Service Bay Diagnostic System (SBDS) can perform two types of EEC system monitoring:

- 60 pin
- Data Stream

60 Pin

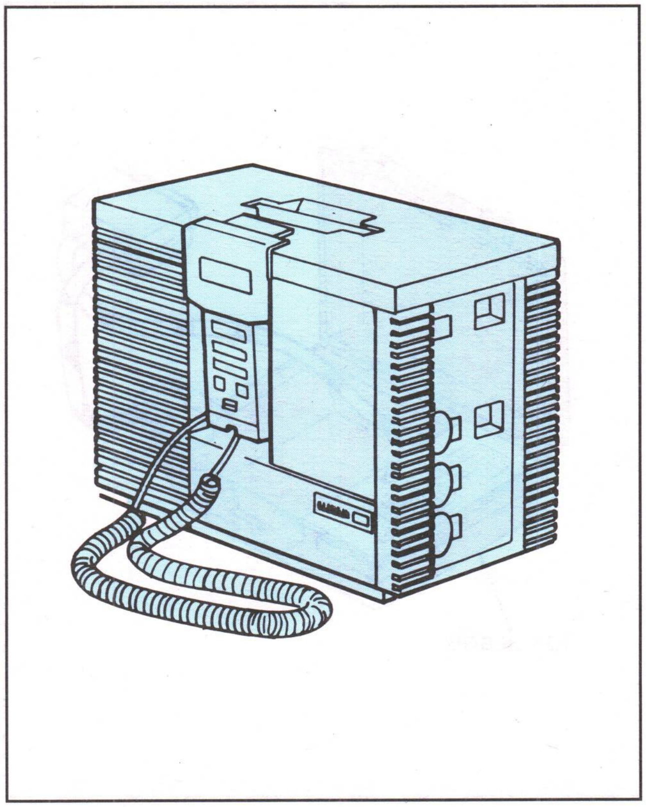


Figure 9-27 — SBDS PVA

Connect the Portable Vehicle Analyzer (PVA) to the PCM, and operate the vehicle. When the concern occurs, press the capture (record) button to record the event. The event can be played back on the SBDS cart. Refer to the appropriate SBDS operating instructions when performing this test.

Data Stream

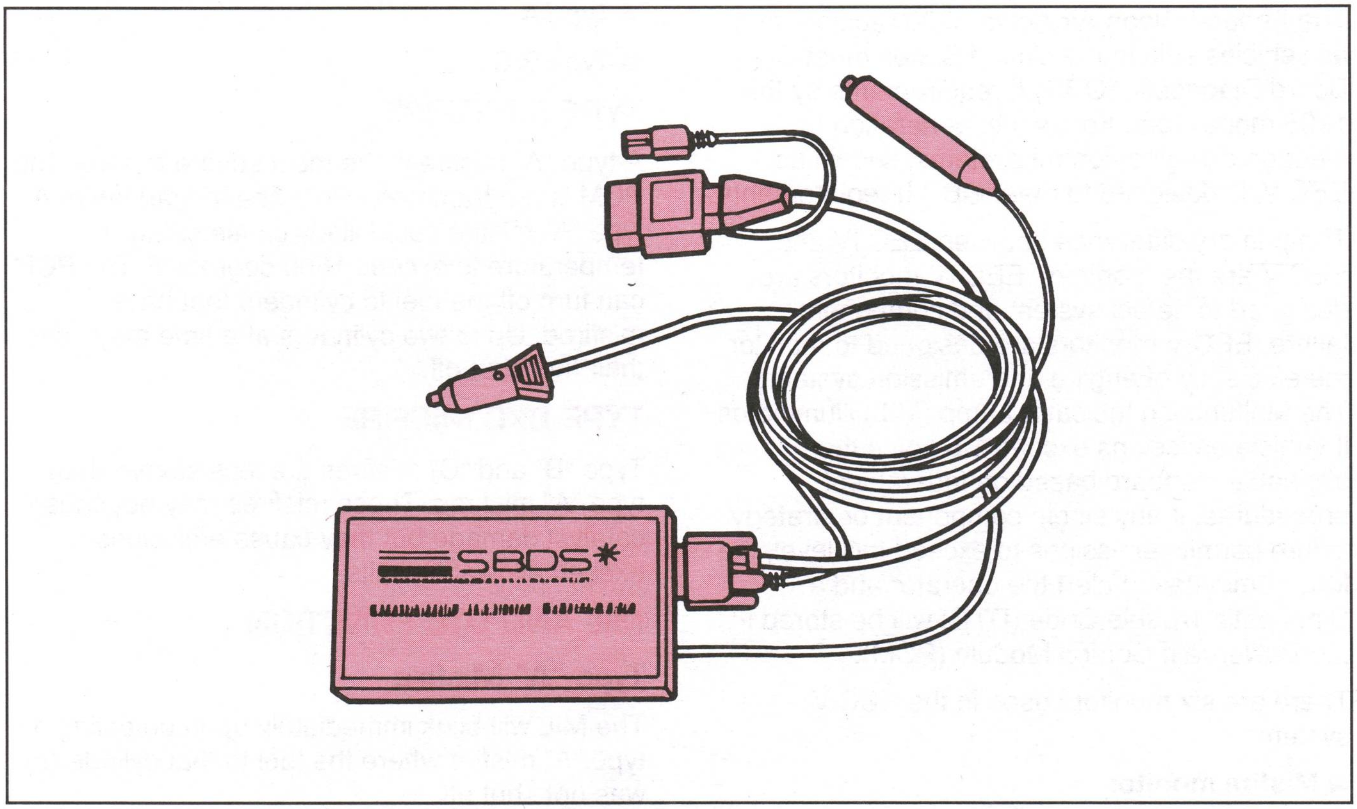


Figure 9-28 — Customer flight recorder

The Customer Flight Recorder (CFR) is used to capture data stream information, on those vehicles that have a data stream. Connect the CFR to the DLC. When the concern occurs press the capture (record) button. The event is recorded and can be replayed and analyzed on the SBDS cart. Refer to the appropriate SBDS operating instructions when performing this test.

NOTE: Not all EEC IV vehicles have a data stream link. Refer to the PCED manual for the vehicle being serviced.

OBD II – EEC V

The Federal Clean Air Act of 1990 requires that all vehicles sold in the United States meet On-Board Diagnostic (OBD) II requirements by the 1996 model year. Ford's fifth generation of electronic engine control systems, known as EEC V, is designed to meet OBD II requirements.

The primary difference between EEC IV and EEC V are the monitors. EEC IV monitors are designed to detect system and component failure. EEC V monitors are designed to monitor the efficiency of engine and emission systems. The Malfunction Indicator Lamp (MIL) illuminates if vehicle emissions exceed 1.5 times the allowable standard based on federal test procedures. If any single component or strategy failure permits emissions to exceed this level, the MIL illuminates to alert the operator and a Diagnostic Trouble Code (DTC) will be stored in the Powertrain Control Module (PCM).

There are six monitors used in the EEC V system:

- **Misfire monitor**
- Comprehensive component monitor
- Fuel system monitor
- EGR monitor
- HO2S monitor
- Catalyst monitor

The monitor systems that are most closely related to the operation of the ignition system are the misfire monitor and the comprehensive component monitor. As a result, only these two monitors will be covered in this lesson. The other monitors of the EEC V system will be covered in detail in the other courses offered in the Engine Performance curriculum.

EEC V Misfire Monitor

The EEC V misfire monitor is a programming strategy of the PCM. The monitor uses the PIP signal to measure crankshaft rotation velocity. The PCM enters a series of calculations to determine the power contributed by each cylinder firing.

There are two misfire monitor thresholds:

- Type A
- Type B/C

TYPE A MISFIRE

A type "A" misfire is the most severe misfire. The PCM is programmed with a speed/load table. A type "A" misfire could likely cause catalyst temperature to exceed 1600 degrees F. The PCM can turn off the fuel to cylinders that have misfired. Up to two cylinders at a time may have their fuel shut off.

TYPE B/C MISFIRE

Type "B" and "C" misfires are less severe than type "A" misfires. These misfires may not cause catalyst damage but may cause emissions to exceed allowable limits.

MIL AND DTC FUNCTION

Type "A" Misfire

The MIL will blink immediately upon detecting a type "A" misfire where the fuel to that cylinder(s) was not shut off.

> **NOTE:** A type "A" misfire is the only condition that will cause the MIL to blink on an EEC V system.

The MIL will illuminate steadily upon detecting a type "A" misfire where the fuel is turned off.

The MIL will turn off if the misfire does not reoccur for three consecutive drive cycles.

A DTC is immediately stored upon detection of a type "A" misfire. The DTC will be erased after 40 consecutive warm-up cycles without a type "A" misfire, once the MIL is turned off.

Type "B/C" Misfire

The MIL turns ON after two malfunctions on separate drive cycles.

The MIL is turned off after three drive cycles without a misfire in the same cylinder under similar operating conditions.

A DTC is stored after the second malfunction. The DTC is erased after 40 consecutive warm-up cycles without reoccurrence once the MIL is turned off.

EEC V Comprehensive Component Monitor

The comprehensive component monitor is a self-test strategy within the PCM. It detects malfunctions of any electronic powertrain component/system that provides input to the PCM and is not exclusively an input to any another OBD II monitor.

The components monitored include the vehicle speed, mass air flow, engine coolant temperature and throttle positions sensors. Outputs monitored by the comprehensive component monitor include the ignition system (includes ID and PIP), fuel pump, low fan control, idle speed control and transmission controls.

Input components are considered to be malfunctioning by the comprehensive component monitor if there is a lack of continuity, or if the input signal is out of range or not in proper relationship to signals it is compared against (this is called a rationality check).

Output components are considered to be malfunctioning by the comprehensive component monitor if there is a lack of continuity or if an expected output response to a PCM command does not occur.

DTCS AND MIL OPERATION

After a malfunction has been present for two drive cycles, the DTC is stored in PCM memory and the MIL is turned on. Once the DTC has been stored in memory, the MIL will stay on as long as the malfunction exists. The MIL is turned off after three consecutive trips without the same malfunction being detected. However, the MIL will stay on if other fault codes, stored in the PCM memory, have independently illuminated the MIL. The DTC will be erased from memory after 40 warm-up cycles without the malfunction being detected after the MIL is turned off. Another method of erasing the DTC is initiating a PCM reset.

EEC V DIAGNOSTIC RESOURCES

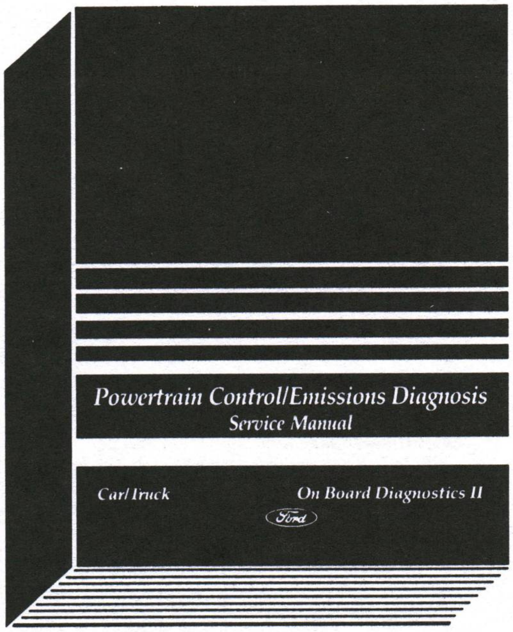
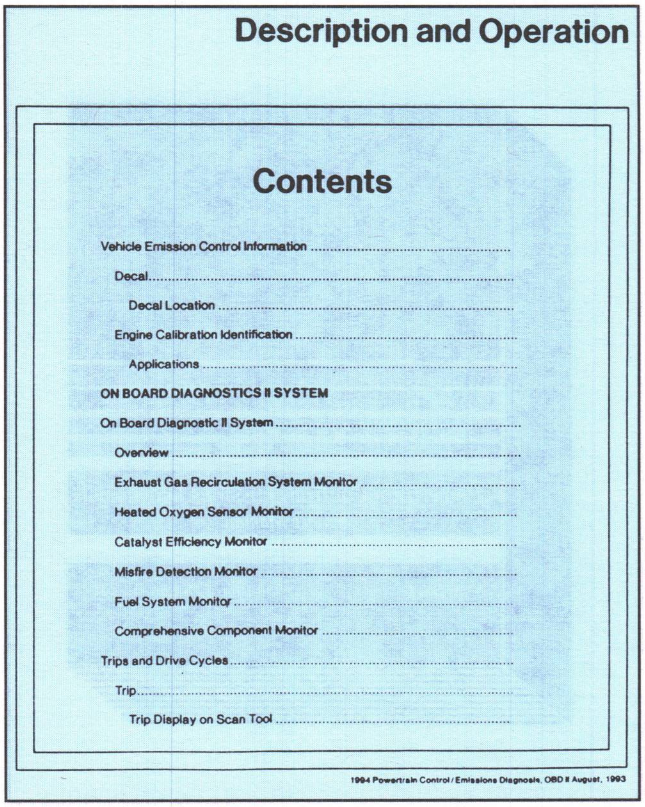


Figure 9-29 — OBD II PCED manual

The On Board Diagnostics (OBD) II PCED manual contains diagnostic and service information for the OBD II/EEC V system. There are six major sections containing diagnostic material:

- Description and Operation
- Diagnostic Methods
- Diagnostic Procedures Overview
- Symptom Flowcharts
- Diagnostic Subroutines
- Pinpoint Tests

Description and Operation



Description and Operation

Contents

- Vehicle Emission Control Information ....
  - Decal..
    - Decal Location ....
  - Engine Calibration Identification ....
    - Applications ....

ON BOARD DIAGNOSTICS II SYSTEM

- On Board Diagnostic II System ....
  - Overview ....
  - Exhaust Gas Recirculation System Monitor ....
  - Heated Oxygen Sensor Monitor...
  - Catalyst Efficiency Monitor ....
  - Misfire Detection Monitor ....
  - Fuel System Monitor..
  - Comprehensive Component Monitor ....
- Trips and Drive Cycles..
  - Trip..
    - Trip Display on Scan Tool ....

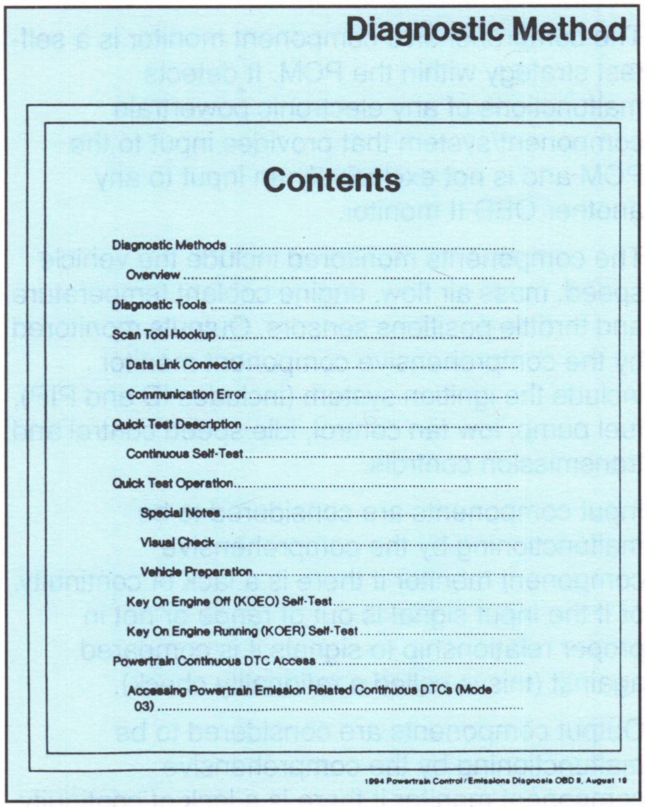
1994 Powertrain Control / Emissions Diagnosis, OBD II August, 1993

Figure 9-30 — OBD II Description and Operation

This section of the OBD II PCED manual contains the following:

- General powertrain control information
- Schematics
- System drawings

Diagnostic Methods



Diagnostic Method

Contents

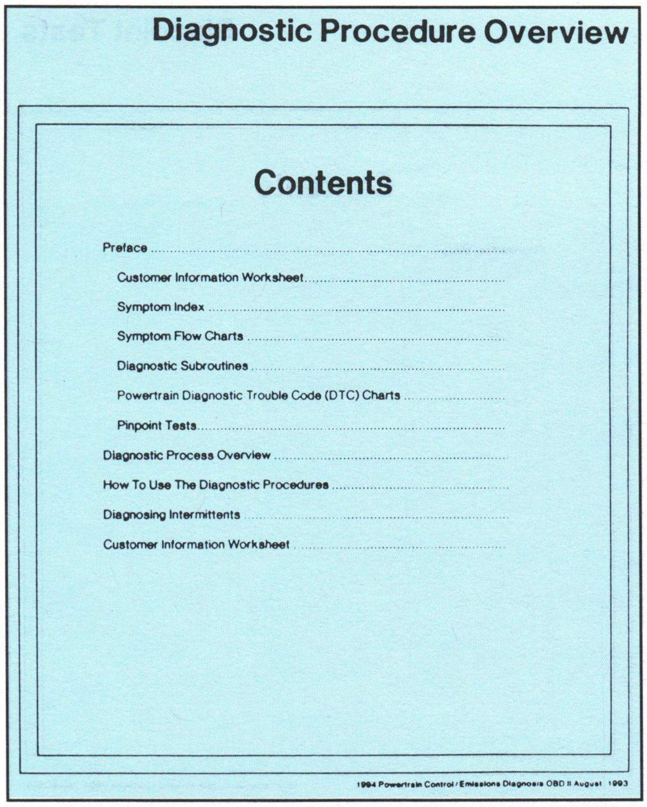
- Diagnostic Methods ....
  - Overview ....
- Diagnostic Tools ....
- Scan Tool Hookup...
  - Data Link Connector...
  - Communication Error ....
- Quick Test Description ....
  - Continuous Self-Test...
- Quick Test Operation...
    - Special Notes..
    - Visual Check ....
    - Vehicle Preparation..
  - Key On Engine Off (KOEO) Self-Test.......................................
  - Key On Engine Running (KOER) Self-Test.................................
- Powertrain Continuous DTC Access ....
  - Accessing Powertrain Emission Related Continuous DTCs (Mode 03) ....

1994 Powertrain Control / Emissions Diagnosis OBD II, August 19

Figure 9-31 — OBD II Diagnostic Methods

This section contains information about specific diagnostic tasks and routine diagnostic instructions.

Diagnostic Procedures Overview



Diagnostic Procedure Overview

Contents

Preface
- Customer Information Worksheet
- Symptom Index
- Symptom Flow Charts
- Diagnostic Subroutines
- Powertrain Diagnostic Trouble Code (DTC) Charts
- Pinpoint Tests

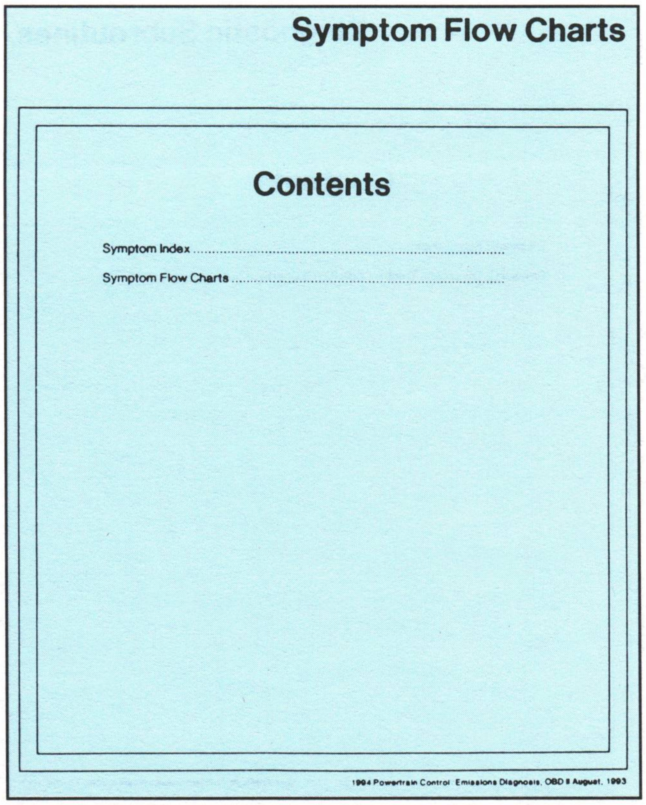
Diagnostic Process Overview
How To Use The Diagnostic Procedures
Diagnosing Intermittents
Customer Information Worksheet

1994 Powertrain Control / Emissions Diagnosis OBD II August 1993

Figure 9-32 — OBD II Diagnostic Procedure Overview

This section provides an overview and detailed instructions for the diagnostic process.

Symptom Flowcharts



Symptom Flow Charts

Contents

Symptom Index
Symptom Flow Charts

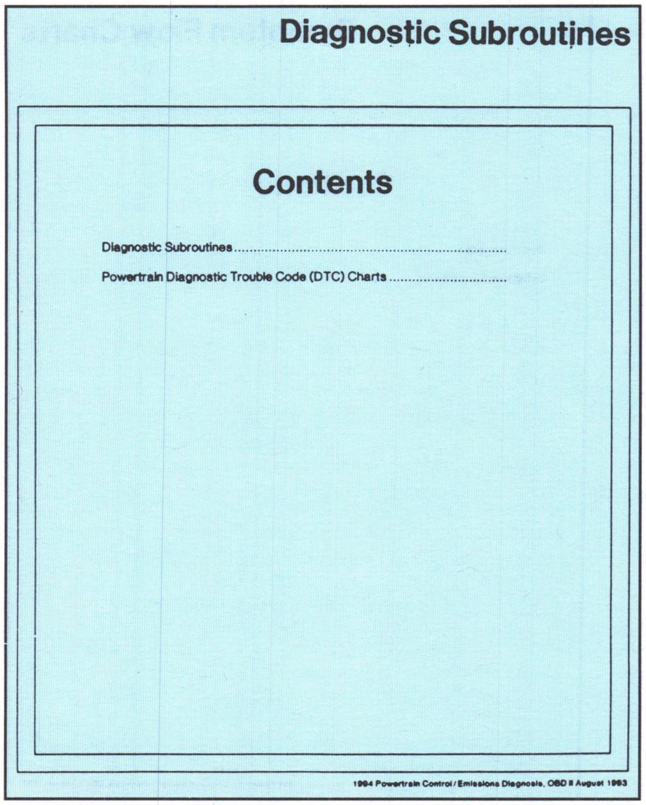
1994 Powertrain Control Emissions Diagnosis, OBD II August, 1993

Figure 9-33 — OBD II Symptom Flowcharts

This section contains guided diagnostic procedures, in the form of flowcharts, based on symptoms.

The diagnostic procedures in the OBD II PCED manual are introduced in this section. Refer to this section of the OBD II PCED manual first when diagnosing an EEC V concern.

Diagnostic Subroutines



Diagnostic Subroutines

Contents

Diagnostic Subroutines ....

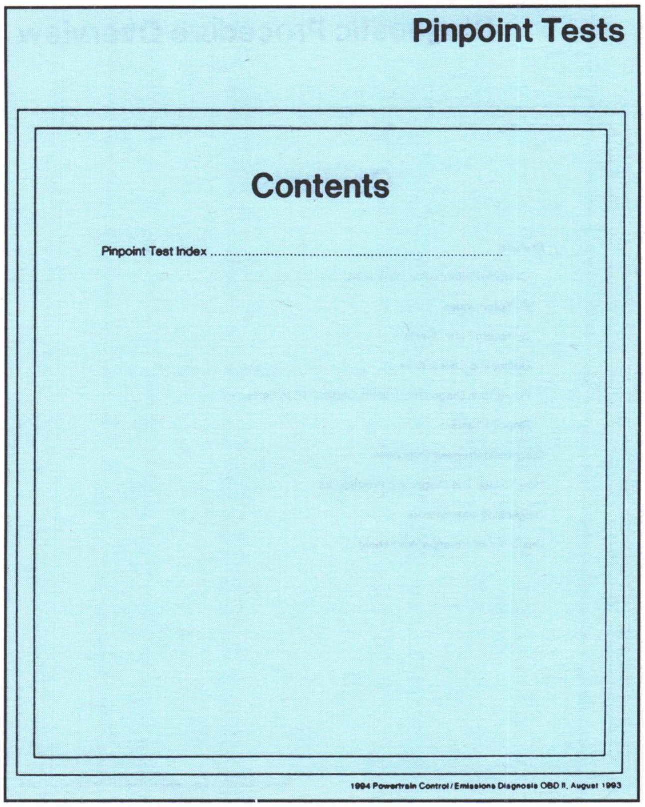
Powertrain Diagnostic Trouble Code (DTC) Charts ....

1994 Powertrain Control / Emissions Diagnosis, OBD II August 1993

Figure 9-34 — OBD II Diagnostic Subroutines

This section contains specific test procedures including EEC V self test. These procedures are intended to provide fast diagnostic information. The diagnostic subroutines should only be performed when referenced from the symptom flowcharts.

PPTs



Pinpoint Tests

Contents

Pinpoint Test Index ....

1994 Powertrain Control / Emissions Diagnosis OBD II, August 1993

Figure 9-35 — OBD II PPTs

PPTs provide step by step instructions for isolating specific concerns. Only refer to PPTs when instructed to do so by the PCED manual.

EEC V DIAGNOSIS AND TESTING

The EEC V system has self diagnostic capabilities similar to EEC IV. The following tests are performed with the EEC V system:

- Quick test
- On Board System Readiness (OSR) test
- Output Test Mode (OTM)
- Parameter Identification (PID) access
- Pinpoint Tests (PPTs)
- Timing tests

These tests are performed with the NGS.

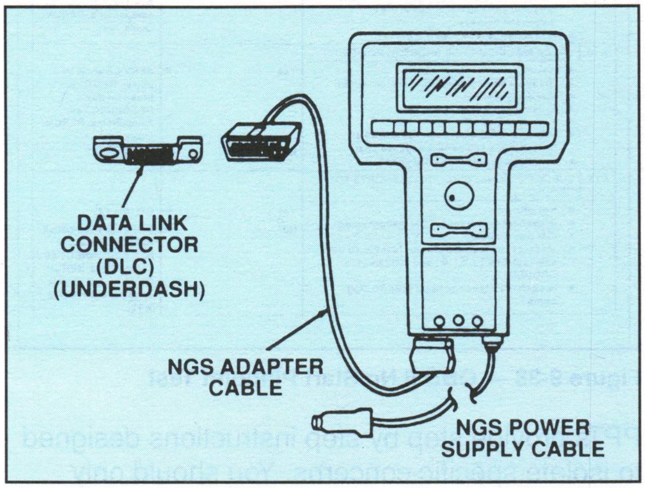


Figure 9-36 — OBD II DLC/NGS

Quick Test

A quick test, which consists of three separate self tests, is used to diagnose EEC V related concerns. The three parts of the quick test are:

- Continuous memory access test
- KOEO self test
- KOER self test

EEC V CONTINUOUS MEMORY ACCESS TEST

Continuous memory Diagnostic Trouble Codes (DTCs) are retrieved using the NGS. DTCs retrieved from memory indicate prior or intermittent faults or faults for circuits/systems that can only be tested during vehicle operations.

Before a KOEO or KOER self test is performed, continuous memory is accessed and any DTCs are recorded.

The purpose of recording any continuous memory DTCs at this time is to ensure that they will not be unintentionally cleared during any Key On, Engine Off (KOEO) or Key On, Engine Running (KOER) DTC service. As always, KOEO and KOER DTCs will be addressed before continuous memory DTCs.

EEC V KOEO SELF TEST

The KOEO self test is performed with the NGS. When the self test is initiated, the PCM enters an interactive test mode. Then it checks various sensors and circuits. DTCs are set when faults are detected. DTCs received during KOEO self test are called hard faults.

EEC V DTCs are 5-characters. The first character identifies the system (P=Powertrain). The second character identifies whether the DTC is OBD II generic or manufacturer specific (0=OBD II generic, 1=Ford specific). The last three characters are the actual DTC.

NOTE: There is no system pass 111 DTC on EEC V systems.

EEC V KOER SELF TEST

The KOER self test is performed using the NGS. When initiated, the PCM enters an interactive test mode. DTCs received during KOER self test are hard faults.

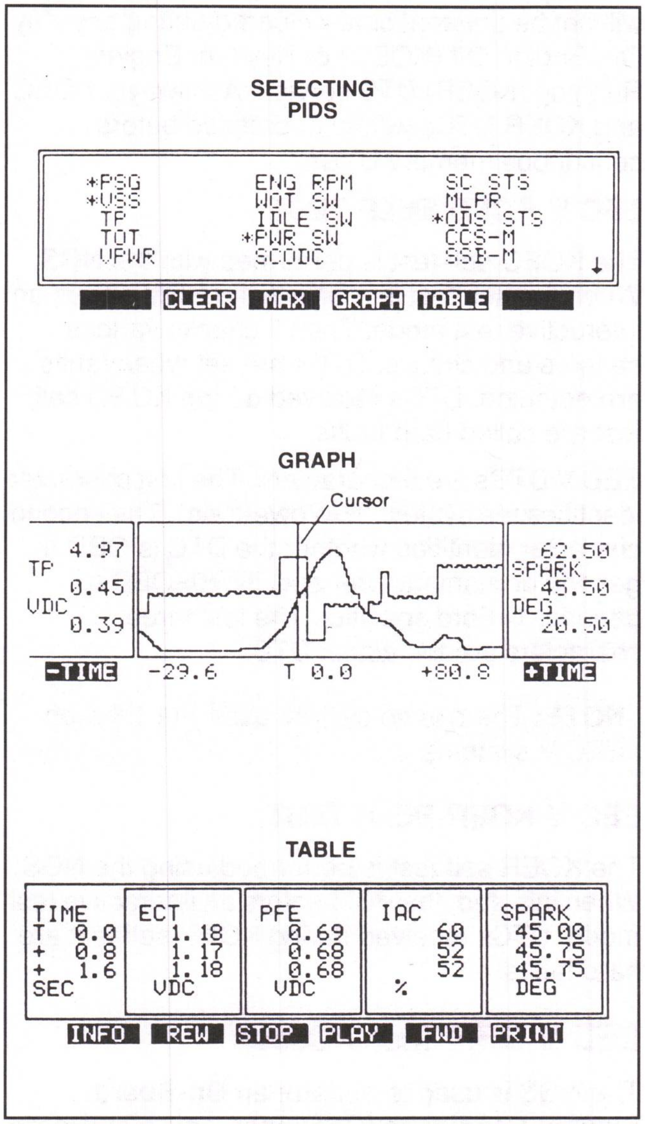
EEC V OSR Test Access

The NGS is used to perform an **On-Board System Readiness (OSR) test**. This test checks the status of the EEC V monitors. The NGS will identify any monitors that are not complete.

EEC V OTM

The **Output Test Mode (OTM)** aids in servicing output actuators associated with the EEC V PCM. Outputs can be turned on and off in this test mode, which is entered through the NGS.

EEC V PID Access

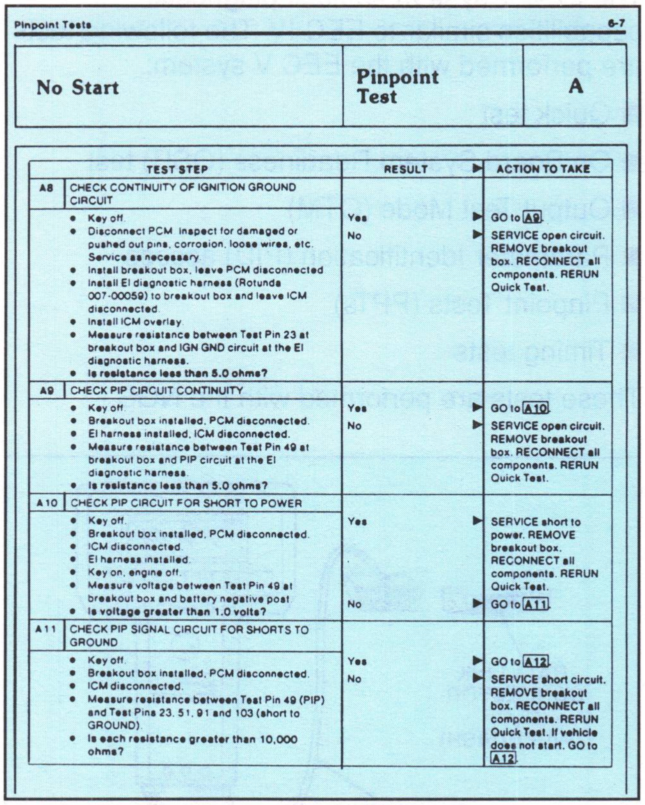


TIME	ECT	PFE	IAC	SPARK
T 0.0	1.18	0.69	60	45.00
+ 0.8	1.17	0.68	52	45.75
+ 1.6	1.18	0.68	52	45.75
SEC	VDC	VDC	%	DEG

Figure 9-37 — OBD II system monitoring

The **Parameter Identification (PID)** test mode allows you to access certain data values through the DLC (data stream) using the NGS. You can use the NGS as a scan tool to monitor PID values for intermittent and hard fault diagnosis.

PPTs



Pinpoint Tests 6-7

No Start	Pinpoint Test	A

TEST STEP		RESULT ▶	ACTION TO TAKE
A8	CHECK CONTINUITY OF IGNITION GROUND CIRCUIT		
	• Key off. • Disconnect PCM. Inspect for damaged or pushed out pins, corrosion, loose wires, etc. Service as necessary. • Install breakout box, leave PCM disconnected • Install EI diagnostic harness (Rotunda 007-00059) to breakout box and leave ICM disconnected. • Install ICM overlay. • Measure resistance between Test Pin 23 at breakout box and IGN GND circuit at the EI diagnostic harness. • Is resistance less than 5.0 ohms?	Yes ▶ No ▶	GO to A9. SERVICE open circuit. REMOVE breakout box. RECONNECT all components. RERUN Quick Test.
A9	CHECK PIP CIRCUIT CONTINUITY		
	• Key off. • Breakout box installed, PCM disconnected. • EI harness installed, ICM disconnected. • Measure resistance between Test Pin 49 at breakout box and PIP circuit at the EI diagnostic harness. • Is resistance less than 5.0 ohms?	Yes ▶ No ▶	GO to A10. SERVICE open circuit. REMOVE breakout box. RECONNECT all components. RERUN Quick Test.
A10	CHECK PIP CIRCUIT FOR SHORT TO POWER		
	• Key off. • Breakout box installed, PCM disconnected. • ICM disconnected. • EI harness installed. • Key on, engine off. • Measure voltage between Test Pin 49 at breakout box and battery negative post. • Is voltage greater than 1.0 volts?	Yes ▶ No ▶	SERVICE short to power. REMOVE breakout box. RECONNECT all components. RERUN Quick Test. GO to A11.
A11	CHECK PIP SIGNAL CIRCUIT FOR SHORTS TO GROUND		
	• Key off. • Breakout box installed, PCM disconnected. • ICM disconnected. • Measure resistance between Test Pin 49 (PIP) and Test Pins 23, 51, 91 and 103 (short to GROUND). • Is each resistance greater than 10,000 ohms?	Yes ▶ No ▶	GO to A12. SERVICE short circuit. REMOVE breakout box. RECONNECT all components. RERUN Quick Test. If vehicle does not start. GO to A12.

Figure 9-38 — OBD II No Start Pinpoint Test

PPTs provide step by step instructions designed to isolate specific concerns. You should only perform PPTs when instructed to do so by the PCED manual.

EEC V Timing Tests

There are two timing checks for vehicles equipped with the EEC V system:

- Base timing
- Computed timing

BASE TIMING

To check base timing, disconnect the in-line SPOUT connector. Use a timing light to check the base timing.

COMPUTED TIMING

There are two methods for checking computed timing:

- Connect the NGS to the DLC and access the **Idle Air Control (IAC)** PID. Disconnect the in-line SPOUT connector while monitoring the IAC PID. Allow the IAC duty cycle to stabilize. Then reconnect the SPOUT connector, and see if the IAC duty cycle changes at least two percent.
- After checking base timing, reconnect the SPOUT and check for timing advance.

EEC V Reference Material

Additional information on the EEC V system may be obtained from the 1994 new model training course "EEC V Powertrain Controls." Order number 0901-312-IGK

This is the end of Lesson 9. Now view Lesson 9 on the video tape, and answer the Progress Check questions.

LESSON 9 – PROGRESS CHECK QUESTIONS

The following questions are based on the information contained in Lesson 9. Choose the **ONE** best correct answer. The answers are provided on the following page. Review any questions missed before proceeding to the next lesson.

1. The EEC and ignition systems interact:
   - A. to produce a high voltage spark.
   - B. to control IDM voltage spikes.
   - C. to control spark timing.
   - D. to control PIP and CID.

2. Technician A says the primary function of both the EEC IV and EEC V systems is the same, as it pertains to the ignition system. Technician B says the diagnostic procedures for both EEC IV and EEC V are the same. Who is correct?
   - A. Technician A
   - B. Technician B
   - C. Both A and B
   - D. Neither A nor B

3. Technician A says the OBD II manual is only needed when diagnosing an EEC V concern relating to the on-board diagnostic monitors. Technician B says to contact OASIS only if normal diagnostics are unsuccessful or if you are dealing with a known concern. Who is correct?
   - A. Technician A
   - B. Technician B
   - C. Both A and B
   - D. Neither A nor B

4. Technician A says EEC self tests should only be performed if the MIL is on. Technician B says EEC self tests do not need to be performed on an EEC V system if the MIL is off. Who is correct?
   - A. Technician A
   - B. Technician B
   - C. Both A and B
   - D. Neither A nor B

LESSON 9 – PROGRESS CHECK ANSWERS

1. The EEC and ignition systems interact:

   A. to produce a high voltage spark.
   B. to control IDM voltage spikes.
   [✓ C.] to control spark timing.
   D. to control PIP and CID.

   Controlling timing is the primary reason the EEC system interacts with the ignition system.

2. Technician A says the primary function of both the EEC IV and EEC V systems is the same, as it pertains to the ignition system. Technician B says the diagnostic procedures for both EEC IV and EEC V are the same. Who is correct?

   [✓ A.] Technician A
   B. Technician B
   C. Both A and B
   D. Neither A nor B

   EEC IV and EEC V systems interact with the ignition system for the same reason, controlling spark timing. However, the diagnostic procedures for EEC IV and EEC V are different.

3. Technician A says the OBD II manual is only needed when diagnosing an EEC V concern relating to the on-board diagnostic monitors. Technician B says to contact OASIS only if normal diagnostics are unsuccessful or if you are dealing with a known concern. Who is correct?

   A. Technician A
   B. Technician B
   C. Both A and B
   [✓ D.] Neither A nor B

   The OBD II manual should be used to diagnose all EEC V driveability emission and powertrain control/system concerns. The OASIS network should be consulted on every job, preferably before proceeding with any diagnostic or service routines.

4. Technician A says EEC self tests should only be performed if the MIL is on. Technician B says EEC self tests do not need to be performed on an EEC V system if the MIL is off. Who is correct?

   A. Technician A
   B. Technician B
   C. Both A and B
   [✓ D.] Neither A nor B

   EEC self tests may be performed on the EEC system when a driveability concern is being diagnosed regardless of whether or not the MIL is on. The symptom flow charts will direct you to the proper diagnostic subroutine(s) for the results of the EEC self test.

LESSON 9 – PROGRESS CHECK QUESTIONS (CONT'D.)

5. Which of the following EEC IV tests does not help isolate intermittent faults?
   - A. Timing tests
   - B. Wiggle test
   - C. Output state test
   - D. EEC monitoring tests

6. Technician A says there are three major parts to an EEC IV quick test. Technician B says EEC IV memory codes are output after KOEO hard fault DTCs are output. Who is correct?
   - A. Technician A
   - B. Technician B
   - C. Both A and B
   - D. Neither A nor B

7. Technician A says a DTC 111 indicates an EEC V system pass. Technician B says a DTC 111 should be erased before the vehicle is returned to the customer. Who is correct?
   - A. Technician A
   - B. Technician B
   - C. Both A and B
   - D. Neither A nor B

8. Technician A says the Super STAR II can be used in place of an NGS when retrieving DTCs on all EEC systems. Technician B says the EEC IV monitor is a good tool to use to isolate intermittent faults with the EEC V system. Who is correct?
   - A. Technician A
   - B. Technician B
   - C. Both A and B
   - D. Neither A nor B

LESSON 9 – PROGRESS CHECK ANSWERS (CONT'D.)

5. Which of the following EEC IV tests does not help isolate intermittent faults?

[✓ A.] Timing tests
B. Wiggle test
C. Output state test
D. EEC monitoring tests

All the other tests are good tests to help isolate intermittent faults. A timing test only tells you if spark timing is correct.

6. Technician A says there are three major parts to an EEC IV quick test. Technician B says EEC IV memory codes are output after KOEO hard fault DTC's are output. Who is correct?

A. Technician A
B. Technician B
[✓ C.] Both A and B
D. Neither A nor B

Quick test is made up of three individual self tests. Memory DTCs are output after all KOEO hard fault codes are output. Refer to the PCED manual.

7. Technician A says a DTC 111 indicates an EEC V system pass. Technician B says a DTC 111 should be erased before the vehicle is returned to the customer. Who is correct?

A. Technician A
B. Technician B
C. Both A and B
[✓ D.] Neither A nor B

A DTC 111 indicates a system pass for EEC IV systems only and does not need to be erased.

8. Technician A says the Super STAR II can be used in place of an NGS when retrieving DTCs on all EEC systems. Technician B says the EEC IV monitor is a good tool to use to isolate intermittent faults with the EEC V system. Who is correct?

A. Technician A
B. Technician B
C. Both A and B
[✓ D.] Neither A nor B

The STAR II will not retrieve DTCs from EEC V systems, and the EEC IV monitor only works with 60 PIN EEC IV systems, not with 104 PIN EEC V systems.

LESSON 9 – PROGRESS CHECK QUESTIONS (CONT'D.)

9. Technician A says that a cylinder balance test can not help identify an ignition related concern. Technician B says that a cylinder balance test can help identify ignition related concerns. Who is correct?

   A. Technician A

   B. Technician B

   C. Both A and B

   D. Neither A nor B

10. Technician A says a cylinder balance test can identify a cylinder with a weak spark condition. Technician B says that a cylinder balance test can be performed on all EEC IV fuel injection systems. Who is correct?

    A. Technician A

    B. Technician B

    C. Both A and B

    D. Neither A nor B

11. A vehicle with a DI system is in the shop for an intermittent stall concern. An EEC quick test was performed and a DTC 211 is present in memory (DTC 211 means two successive erratic PIP pulses occurred). There are no KOEO or KOER hard faults; and base and computed timing check ok. What is the next step?

    A. Erase the memory DTC, and see if it returns within the next 40 driving cycles.

    B. Erase the memory DTC, replace the CMP sensor and see if the DTC or concern re-occur.

    C. Perform an output state test.

    D. Perform a PPT.

LESSON 9 – PROGRESS CHECK ANSWERS (CONT'D.)

9. Technician A says that a cylinder balance test can not help identify an ignition related concern. Technician B says that a cylinder balance test can help identify ignition related concerns. Who is correct?

A. Technician A
[✓ B.] Technician B
C. Both A and B
D. Neither A nor B

A cylinder balance test can identify weak and non-contributing cylinders regardless of the cause.

10. Technician A says a cylinder balance test can identify a cylinder with a weak spark condition. Technician B says that a cylinder balance test can be performed on all EEC IV fuel injection systems. Who is correct?

[✓ A.] Technician A
B. Technician B
C. Both A and B
D. Neither A nor B

A cylinder balance test will identify a cylinder with a weak spark because that cylinder will not be contributing efficiently. A cylinder balance test can only be performed on vehicles with SFI systems.

11. A vehicle with a DI system is in the shop for an intermittent stall concern. An EEC quick test was performed and a DTC 211 is present in memory (DTC 211 means two successive erratic PIP pulses occurred). There are no KOEO or KOER hard faults; and base and computed timing check ok. What is the next step?

A. Erase the memory DTC and see if it returns within the next 40 driving cycles.
B. Erase the memory DTC, replace the CMP sensor and see if the DTC or concern re-occur.
C. Perform an output state test.
[✓ D.] Perform a PPT.

The procedure outlined by the PCED manual is to perform a PPT. You should never replace a component without having first verified that it needs to be replaced through proper testing.

LESSON 9 – PROGRESS CHECK QUESTIONS (CONT'D.)

12. Technician A says an intermittent buck/jerk symptom could be the result of an erratic PIP signal. Technician B says the PIP signal, on an EEC IV system, can be monitored during vehicle operation with an EEC IV monitor or BOB and DVOM. Who is correct?

    A. Technician A

    B. Technician B

    C. Both A and B

    D. Neither A nor B

13. Technician A says the EEC IV monitor is used to perform a 60 pin monitor of the EEC V system, and the NGS is used to monitor the EEC V data stream. Technician B says to install the EEC IV monitor to an EEC V vehicle an adapter is needed. Who is correct?

    A. Technician A

    B. Technician B

    C. Both A and B

    D. Neither A nor B

14. Technician A says when performing a KOEO self test on a vehicle with EEC V that a DTC 111 means the system passes. Technician B says that if no codes are output during a KOEO self test on an EEC IV system, further diagnostic steps are required. Who is correct?

    A. Technician A

    B. Technician B

    C. Both A and B

    D. Neither A nor B

LESSON 9 – PROGRESS CHECK ANSWERS (CONT'D.)

12. Technician A says an intermittent buck/jerk symptom could be the result of an erratic PIP signal. Technician B says the PIP signal, on an EEC IV system, can be monitored during vehicle operation with an EEC IV monitor or BOB and DVOM. Who is correct?

A. Technician A

B. Technician B

[✓ C.] Both A and B

D. Neither A nor B

An erratic PIP signal could cause erratic ignition system operation. An intermittent loss of spark could result which could create a buck/jerk symptom. The EEC IV monitor or BOB and DVOM can be used to monitor the PIP signal on EEC IV equipped vehicles.

13. Technician A says the EEC IV monitor is used to perform a 60 pin monitor of the EEC V system, and the NGS is used to monitor the EEC V data stream. Technician B says to install the EEC IV monitor to an EEC V vehicle an adapter is needed. Who is correct?

A. Technician A

B. Technician B

C. Both A and B

[✓ D.] Neither A nor B

Neither the EEC IV monitor or EEC IV BOB are compatible with EEC V systems. The NGS is used to perform EEC V quick test functions and access the EEC V data stream. The EEC V 104 pin BOB is the only BOB that can be used with the EEC V system.

14. Technician A says when performing a KOEO self test on a vehicle with EEC V that a DTC 111 means the system passes. Technician B says that if no codes are output during a KOEO self test on an EEC IV system, further diagnostic steps are required. Who is correct?

A. Technician A

[✓ B.] Technician B

C. Both A and B

D. Neither A nor B

DTC 111 is not an EEC V DTC because all EEC V DTCs have 5 characters. DTC 111 is an EEC IV DTC. If no codes are output during a KOEO self test on an EEC IV system, further diagnostic steps are necessary. A DTC, passing or otherwise, should be output during the self test. If no DTC is output there could be a problem with the data communication link, the tester or the PCM. Refer to the PCED manual for testing procedures.

LESSON 9 – PROGRESS CHECK QUESTIONS (CONT'D.)

15. What procedure is used to check base timing on an EEC V system?
    - A. Disconnect the in-line SPOUT connector, ground the STI connector and use a timing light to check the timing.
    - B. Run the engine at 2000 RPM for 20 seconds, stabilize the idle and use a timing light to check the idle.
    - C. Connect the NGS to the DLC, access the SPOUT PID and read the timing off the NGS display.
    - D. Use a timing light and check the timing with the SPOUT in-line connector disconnected and the engine warm and at idle.

16. What procedure is used to check computed timing on an EEC V vehicle?
    - A. Use a timing light and run the engine at 2000 RPM.
    - B. Use the NGS, access the IAC PID and monitor the duty cycle with the SPOUT connector connected and disconnected.
    - C. Use the NGS and monitor the SPOUT PID with the SPOUT connector connected and disconnected.
    - D. Use the 104 pin BOB and measure the SPOUT voltage with the SPOUT connector connected and disconnected.

LESSON 9 – PROGRESS CHECK ANSWERS (CONT'D.)

15. What procedure is used to check base timing on an EEC V system?

    A. Disconnect the in-line SPOUT connector, ground the STI connector and use a timing light to check the timing.

    B. Run the engine at 2000 RPM for 20 seconds, stabilize the idle and use a timing light to check the idle.

    C. Connect the NGS to the DLC, access the SPOUT PID and read the timing off the NGS display.

    [✓ D.] Use a timing light and check the timing with the SPOUT in-line connector disconnected and the engine warm and at idle.

    This is the only correct procedure for checking base timing on an EEC V vehicle. Refer to the OBD II manual.

16. What procedure is used to check computed timing on an EEC V vehicle?

    A. Use a timing light and run the engine at 2000 RPM.

    [✓ B.] Use the NGS, access the IAC PID and monitor the duty cycle with the SPOUT connector connected and disconnected.

    C. Use the NGS and monitor the SPOUT PID with the SPOUT connector connected and disconnected.

    D. Use the 104 pin BOB and measure the SPOUT voltage with the SPOUT connector connected and disconnected.

ASSOCIATION VEHICLE IGNITION SYSTEMS

INTRODUCTION

Vehicles designed in North America are considered to be NAAO vehicles (North American Automotive Operations). Vehicles designed outside of North America are considered to be Association Vehicles.

The following lessons will introduce you to the ignition and engine control systems used on these vehicles. These systems include:

- DI Ignition with electronic timing control
- DI Ignition with mechanical timing control
- Villager DI Ignition System

You will also learn about the diagnostic and testing methods that are unique and different.

While there are several differences between Association and NAAO vehicles, there are also many similarities. The following lessons will point out these differences and similarities.

IGNITION SYSTEM THEORY AND OPERATION

Lesson **1** Spark and Ignition

Lesson **2** Basic Ignition

Lesson **3** Ignition Requirements and Operating Modes

Lesson **4** Ignition Related Driveability Symptoms

Lesson **5** Basic Testing

NAAO

Lesson **6** DI Ignition System

Lesson **7** EI – Low Data Rate Ignition System

Lesson **8** EI – High Data Rate Ignition System

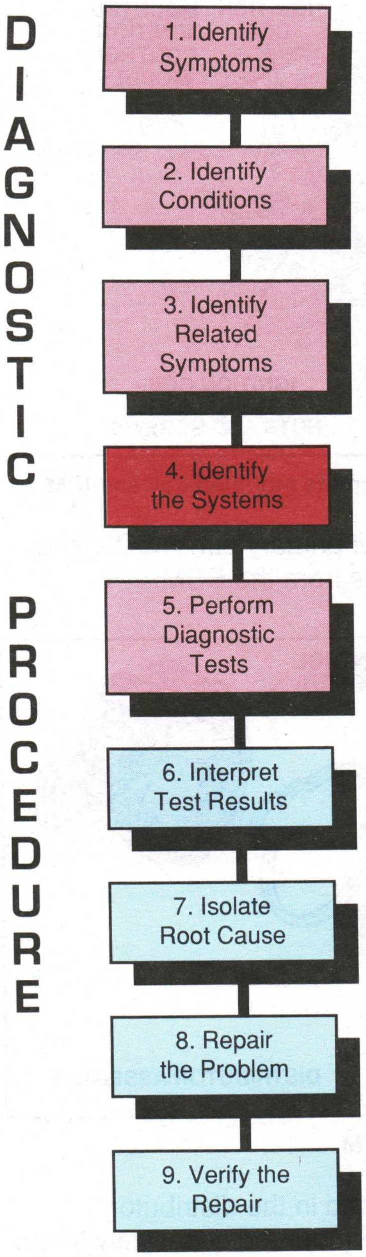
Lesson **9** EEC System Diagnosis

ASSOCIATION

Lesson **10** DI Electronically Controlled Timing

Lesson **11** DI Mechanically Controlled Timing

Lesson **12** Villager DI Ignition System



LESSON 10: DI ELECTRONICALLY CONTROLLED TIMING

This lesson will cover the DI system with electronic timing control. This system is very similar to the NAAO DI system previously covered.

Where does this lesson fit into the diagnostic procedure?

The information in this lesson relates to step 4 of the diagnostic procedure. It covers the operation, diagnosis and testing of the DI electronically controlled timing system used on association vehicles.

Objective(s):

The information in this lesson will enable you to:

- Identify and describe the operation of the ignition system components and describe their functions in operating as a system.
- Identify and describe ignition system diagnostic procedures and test equipment.

PRIMARY IGNITION SYSTEM

The primary system contains the following components:

- Powertrain Control Module (PCM)
- Ignition Control Module (ICM)
- Engine Speed and Position Sensors
- Coil
- Primary Circuitry

Powertrain Control Module

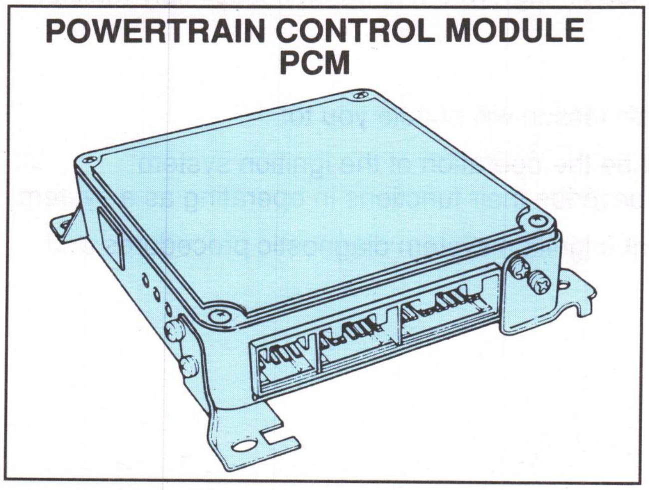


Figure 10-1 — PCM

The PCM works with the ICM to control spark timing by signaling the ICM when to “fire” the coil. The PCM is located under the dash inside the passenger compartment.

Ignition Control Module

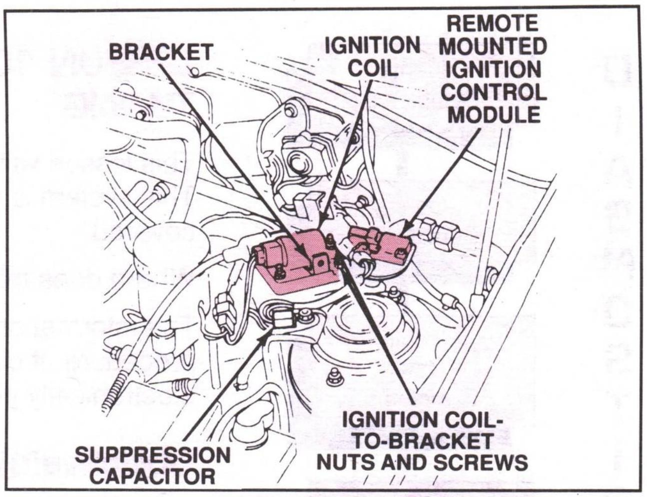

BRACKET
IGNITION COIL
REMOTE MOUNTED IGNITION CONTROL MODULE
SUPPRESSION CAPACITOR
IGNITION COIL-TO-BRACKET NUTS AND SCREWS

Figure 10-2 — Typical remote mounted coil and ICM

The ICM switches coil primary current ON and OFF based on signals from the PCM.

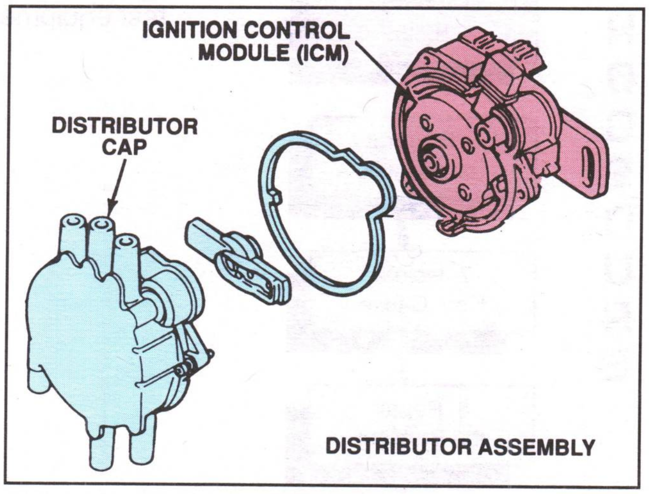


Figure 10-3 — Integral ICM

The ICM may be located in the distributor assembly or it may be mounted separately in the engine compartment.

Engine Speed and Position Sensors

There are three methods used to detect and transmit engine speed and position information.

METHOD 1

This method uses a CKP sensor and a CID sensor. The CKP signal provides engine speed and crankshaft position data to the PCM. The CID provides piston position data to the PCM. The CKP and CID sensors are **phototransistor** or **optical** type sensors and are located in the distributor.

Currently the 1.8L engine used in the Escort and Tracer use this method.

Optical Sensors

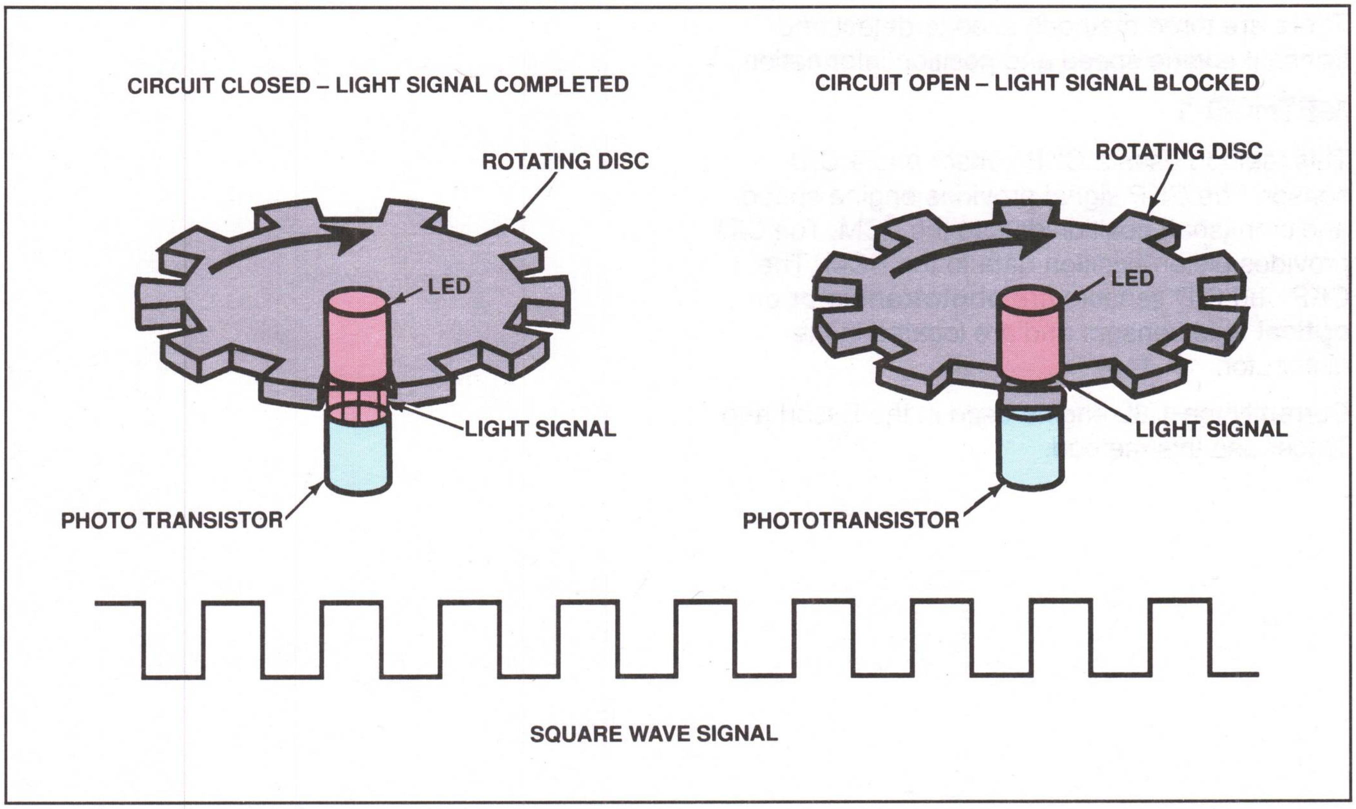


Figure 10-4 — Optical sensor operation

An optical, or phototransistor, type sensor consists of a Light Emitting Diode (LED), a phototransistor and a rotating disc with slots cut into it. A high reference voltage (5.0 volts) is delivered by the PCM or the distributor (depending on vehicle application). As slots in the disc pass between the phototransistor and LED, the circuit between the two is opened and closed. This generates a square wave signal that is used by the PCM for coil control.

Crankshaft Position Sensor

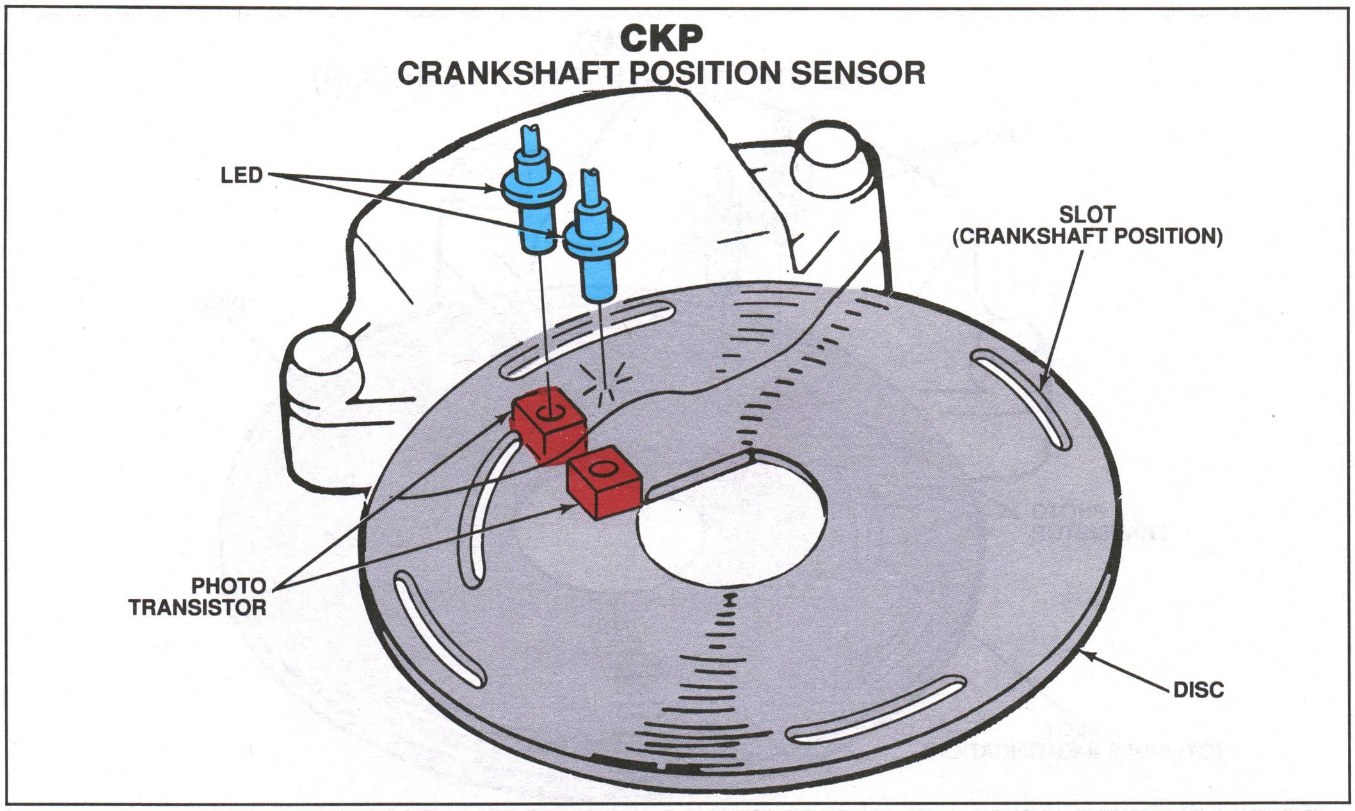


Figure 10-5 — CKP sensor and rotating disc

The portion of the rotating disc that passes through the CKP contains four slots. For ignition purposes, this process sends a PIP signal to the PCM. The PIP signal is the primary ignition input signal.

Cylinder Identification Sensor

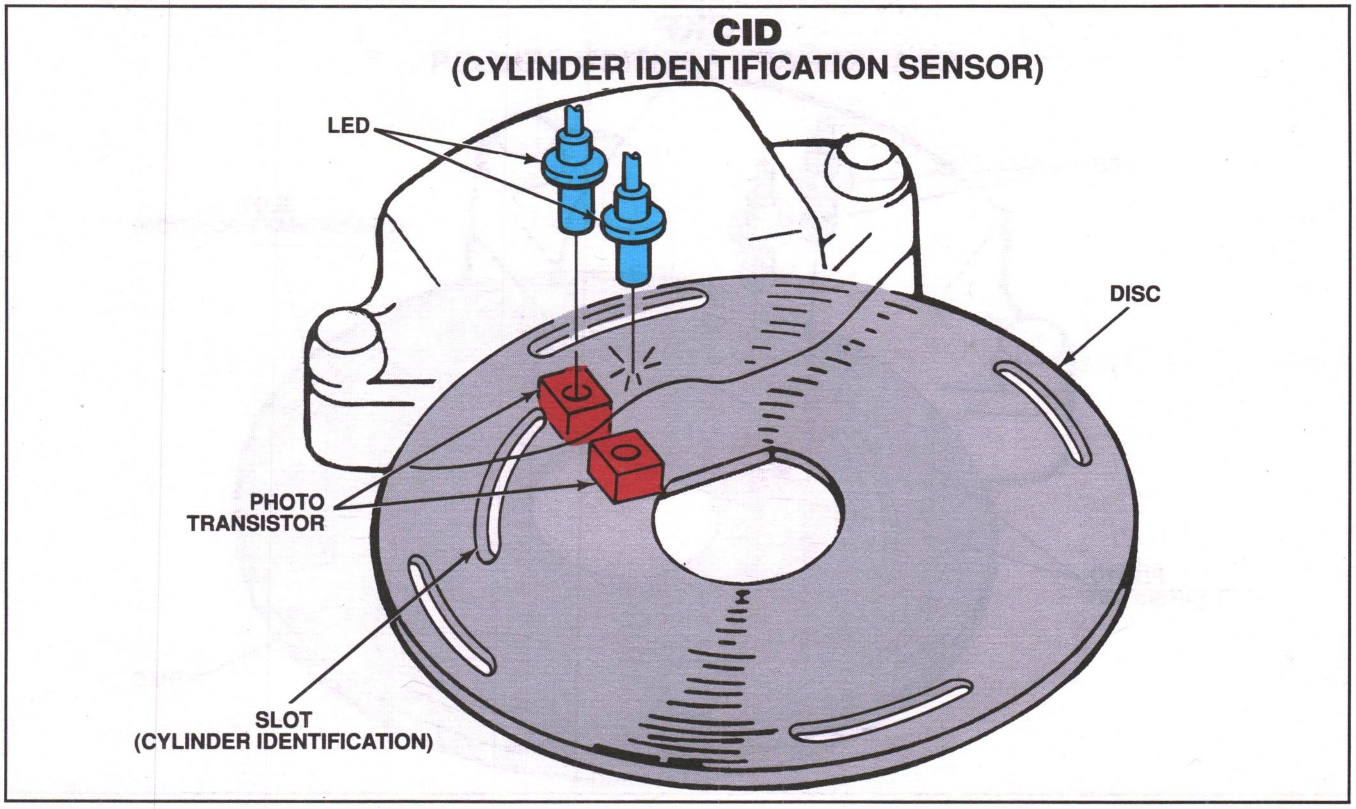


Figure 10-6 — CID sensor and rotating disc

The portion of the rotating disc that passes through the CID contains one slot. This slot provides a reference point indicating when a cylinder pair is at TDC. This input is used primarily for fuel control purposes. It does, however, serve as a backup to the CKP if there is a loss of CKP signal.

METHOD 2

CRANKSHAFT POSITION SENSOR

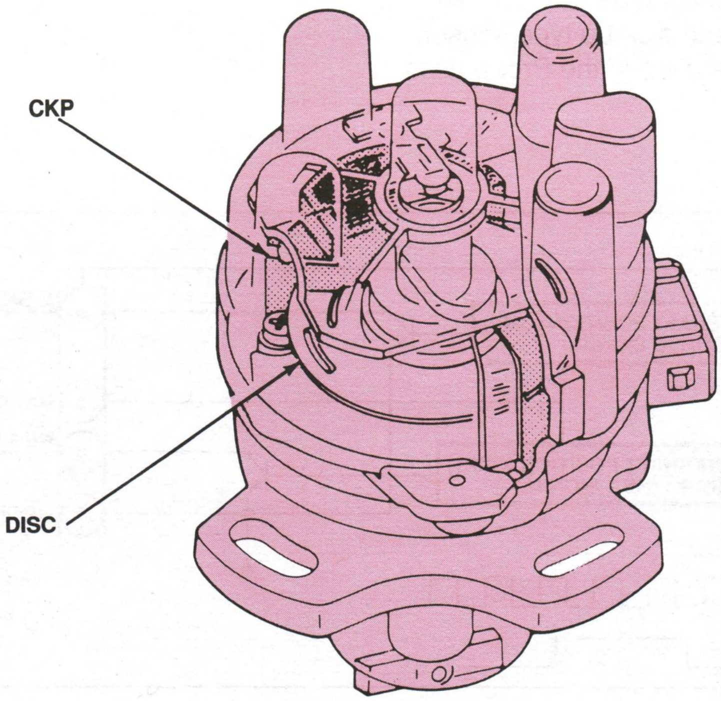


Figure 10-7 — Single optical CKP sensor

This method uses a single optical CKP sensor. The sensor is located in the distributor and provides a PIP signal for the PCM.

Currently the 1.3L engine used in the Festiva and Aspire use this method.

METHOD 3

The third method uses a CID sensor and two CKP sensors, CKP1 and CKP2. The CID and CKP1 sensors are Hall effect type sensors. The CKP2 sensor is a magnetic pick-up type sensor. Currently the 2.5L engine used in the Probe uses this method.

CID

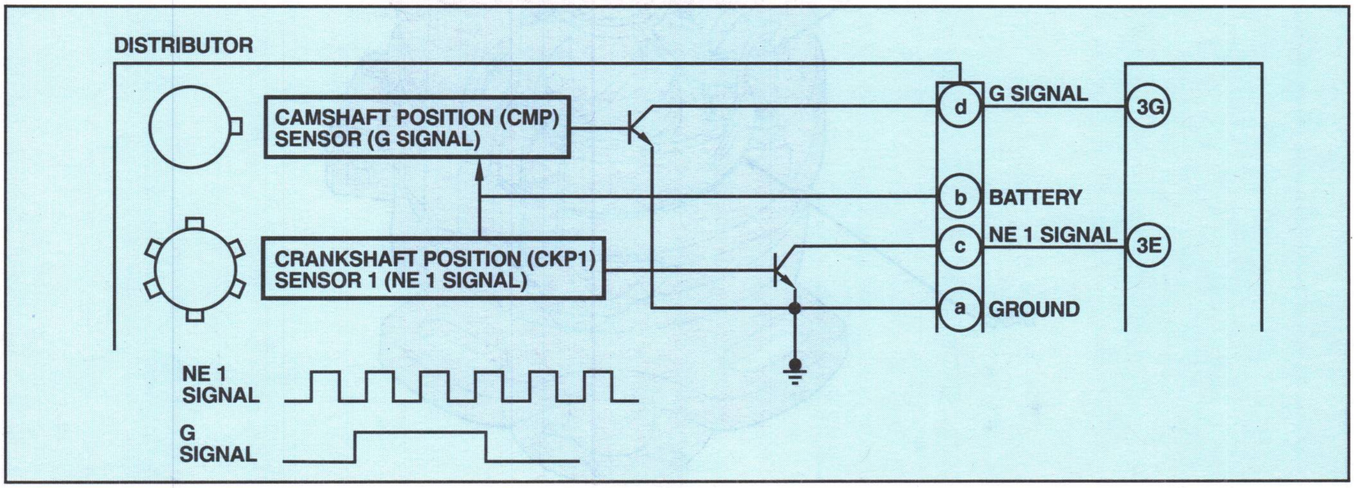

DISTRIBUTOR
CAMSHAFT POSITION (CMP) SENSOR (G SIGNAL)
CRANKSHAFT POSITION (CKP1) SENSOR 1 (NE 1 SIGNAL)
d
G SIGNAL
3G
b
BATTERY
c
NE 1 SIGNAL
3E
a
GROUND
NE 1 SIGNAL
G SIGNAL

Figure 10-8 — CID sensor

The CID sensor is mounted in the distributor and sends a CID signal to the PCM. This signal is used to detect TDC of cylinder number one.

CKP1

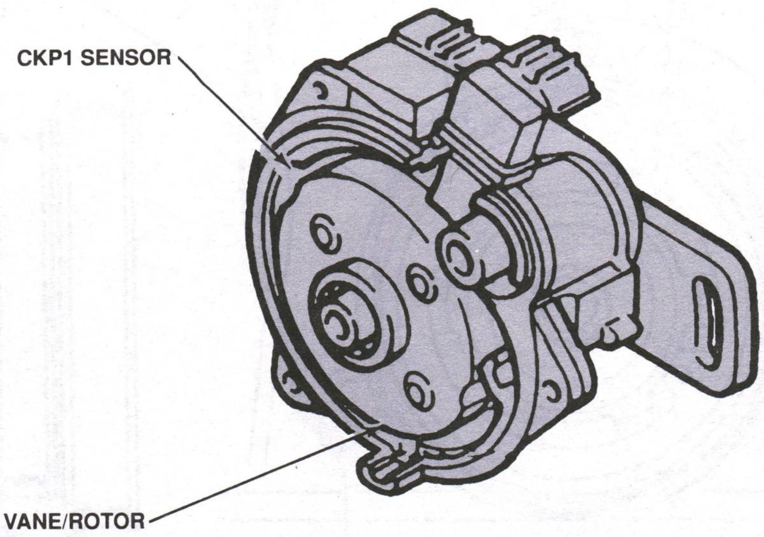


Figure 10-9 — CKP1 sensor

The CKP1 sensor is located in the distributor and consists of a vane/rotor (which is mounted to the distributor shaft) and a Hall effect device. As each vane passes through the Hall device, a signal is generated and sent to the PCM. This signal determines crankshaft position.

CKP2

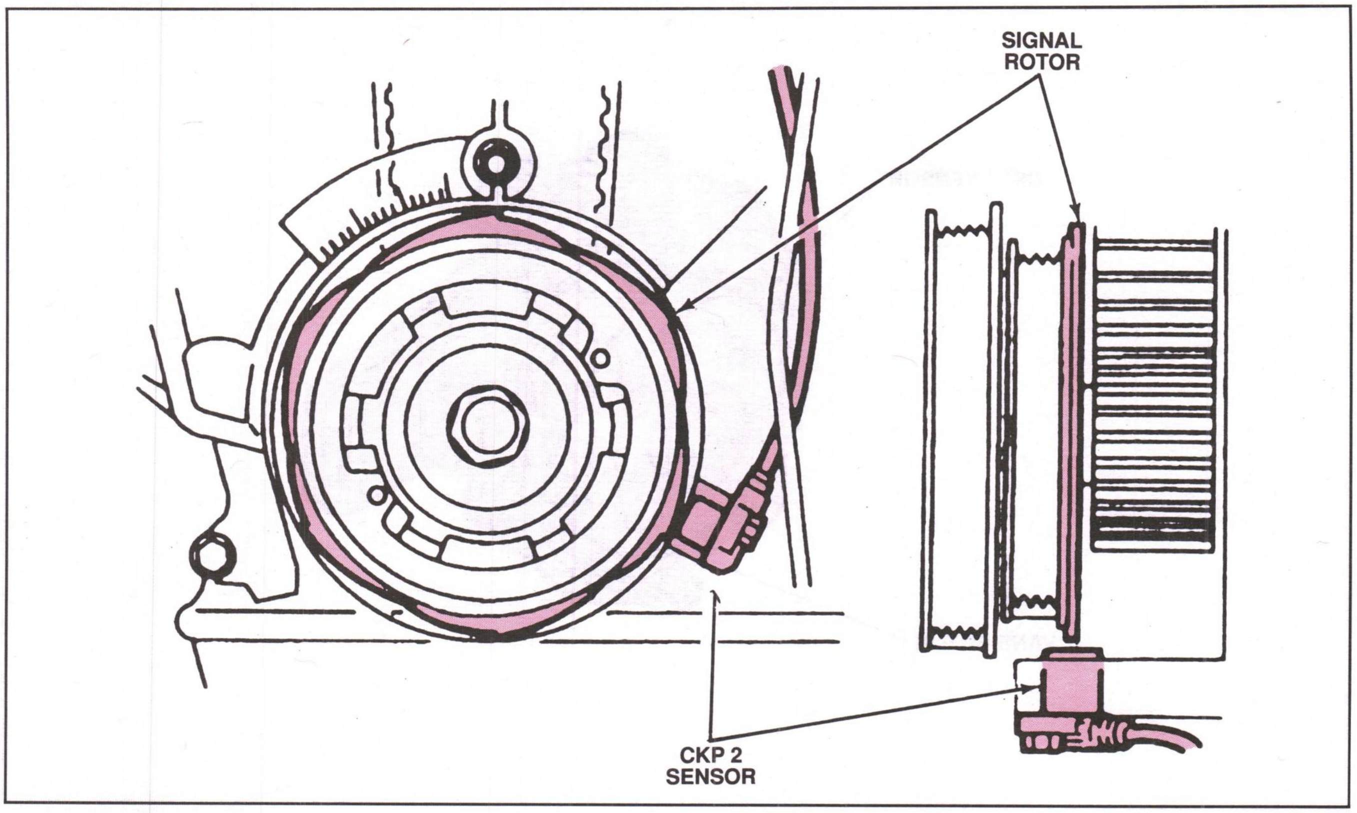


Figure 10-10 — CKP2 sensor

The CKP2 sensor is mounted on the crankshaft pulley. It consists of a rotor with projectiles and a magnetic pick-up. As the projectiles pass the magnetic pick-up, a signal is generated and sent to the PCM. The CKP2 signal is the main, or primary, signal used by the PCM. The CKP1 signal is used for starting and as a backup to the CKP2 signal in the event of CKP2 signal is lost.

Coil

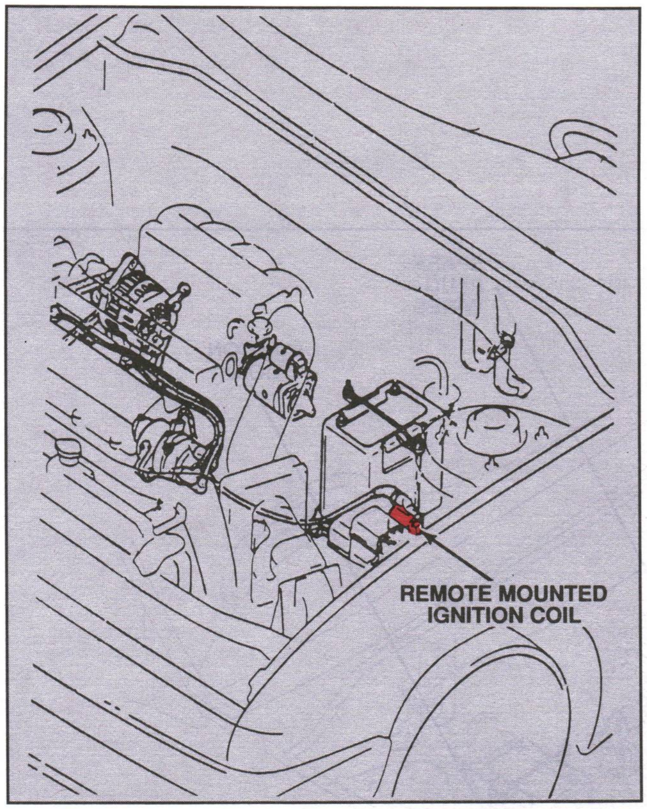


Figure 10-11 — Remote mounted coil

The purpose of the ignition coil is the same for Association and NAAO DI systems. Both use coils that have primary and secondary windings, and both produce high secondary voltage through magnetic induction.

The ignition coil may be mounted in a remote location in the engine compartment, or it may be located in the distributor. Refer to the vehicle's service manual for location and servicing procedures.

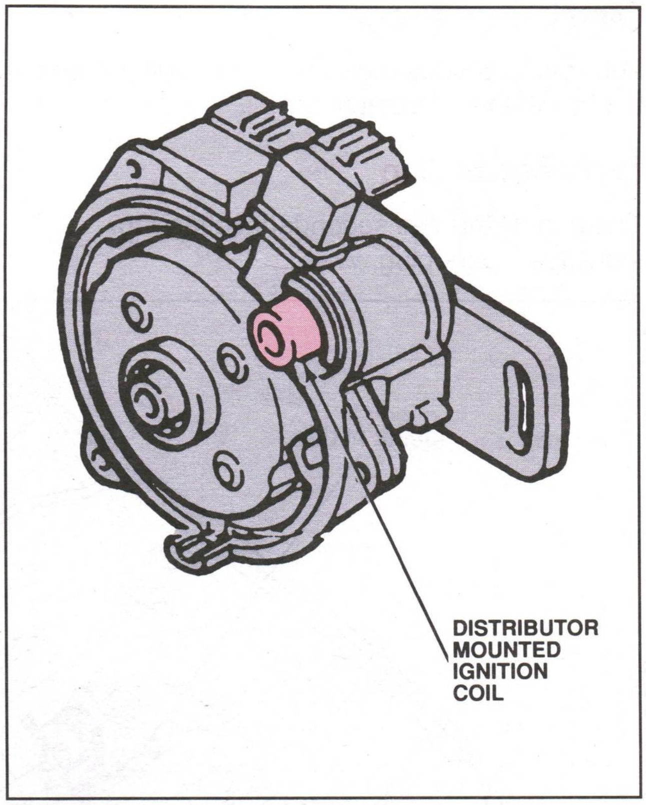


Figure 10-12 — Integral coil

Primary Circuits

The primary circuits carry the low voltage current used by the ignition system. These include the following: ICM, PCM, CID, CKP, coil voltage supply and coil ground circuits.

SECONDARY SUB-SYSTEM

The secondary sub-system is responsible for delivering high voltage current to the combustion chamber. Secondary sub-system components include the following:

- Ignition coil — secondary windings
- Distributor rotor
- Distributor cap
- Secondary circuits (spark plug wires)
- Spark plugs

Ignition Coil - Secondary Windings

High voltage, in excess of 10 kv, is induced in the secondary windings. This high voltage is needed to arc the gap between the spark plug's electrodes.

Distributor Rotor

The rotor transfers high secondary voltage from the coil to the distributor cap.

Distributor Cap

The cap distributes secondary voltage to individual spark plug wires.

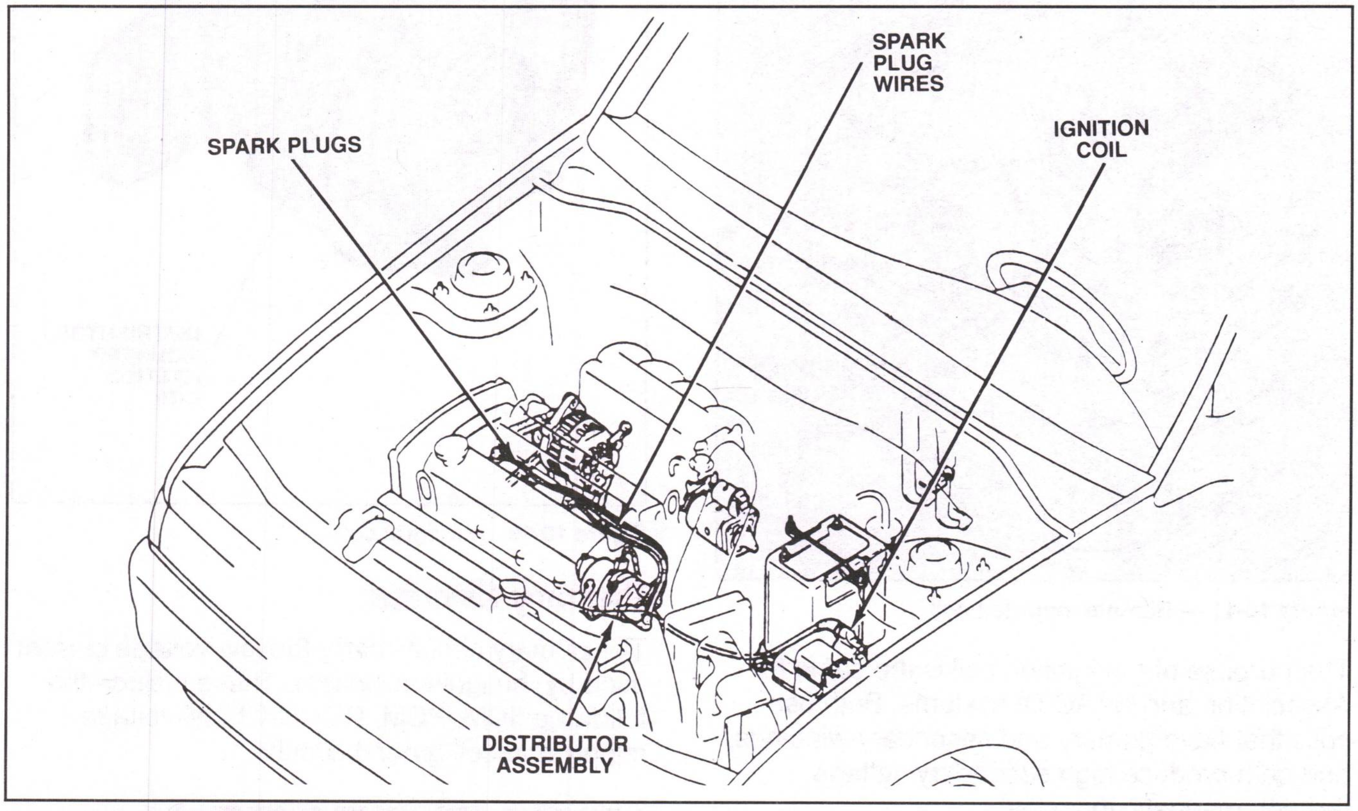


Figure 10-13 — Secondary ignition components

Secondary Circuits (Spark Plug Wires)

Secondary circuits carry secondary voltage to the spark plugs. These circuits are easily identified by their thick insulation.

Spark Plugs

The spark plugs are inserted in the combustion chamber and create the spark for combustion.

DI – ELECTRONICALLY CONTROLLED TIMING

TIMING CONTROL

Spark timing is controlled electronically in much the same way as it is controlled on the NAAO DI system. The PCM calculates spark timing based on input received from various sensors. These inputs include information about engine speed, vehicle speed and engine load.

SPOUT

The PCM sends a SPOUT signal to the ICM, and the ICM fires the coil in response to the SPark OUTput (SPOUT) signal.

TIMING CONTROL COMPARISON

The ICMs used on NAAO vehicles fire the coil in response to a SPOUT signal. However, if the SPOUT signal is lost, the system continues to operate (timing fixed at base). This is because both the ICM and PCM receive engine speed and position data from the CKP and/or CMP sensor(s).

Engine speed and position data on Association vehicles are only received by the PCM. Therefore the ICM must receive a SPOUT signal to fire the coil.

DIAGNOSIS AND TESTING

Many of the components used in this DI system are similar to those used on NAAO DI systems. The operation of this system is also very similar. As a result many of the testing techniques are similar. For example, basic primary and secondary tests are performed the same way and with the same equipment as on NAAO vehicles. The following information covers only those tests and diagnostic methods that are different.

Engine Control System

The major difference between NAAO and Association vehicles is the Electronic Engine Control (EEC) system. Both EEC systems perform the same function, but the operating strategies and diagnostic techniques are slightly different.

DIAGNOSTIC RESOURCES

The following resources contain diagnostic and service information on the EEC and ignition systems:

- Powertrain Control/Emissions Diagnosis (PCED) manual
- Electrical Vacuum Troubleshooting manuals (EVTMs)
- Technical Service Bulletins (TSBs)
- Shop manuals
- On-Line Automotive Service Information System (OASIS)

Powertrain Control/Emissions Diagnosis Manual

CAR SERVICE MANUAL

Powertrain Control/Emissions Diagnosis

— Powertrain Control Systems Not Designed In North America —

Figure 10-14 — Association vehicle PCED manual

The PCED provides diagnostic and operational information on the EEC and ignition systems. All Association vehicle information is contained in the “B” sections of the manual. The “B” sections are formatted the same way as the “A” sections.

Electrical Vacuum Troubleshooting Manuals

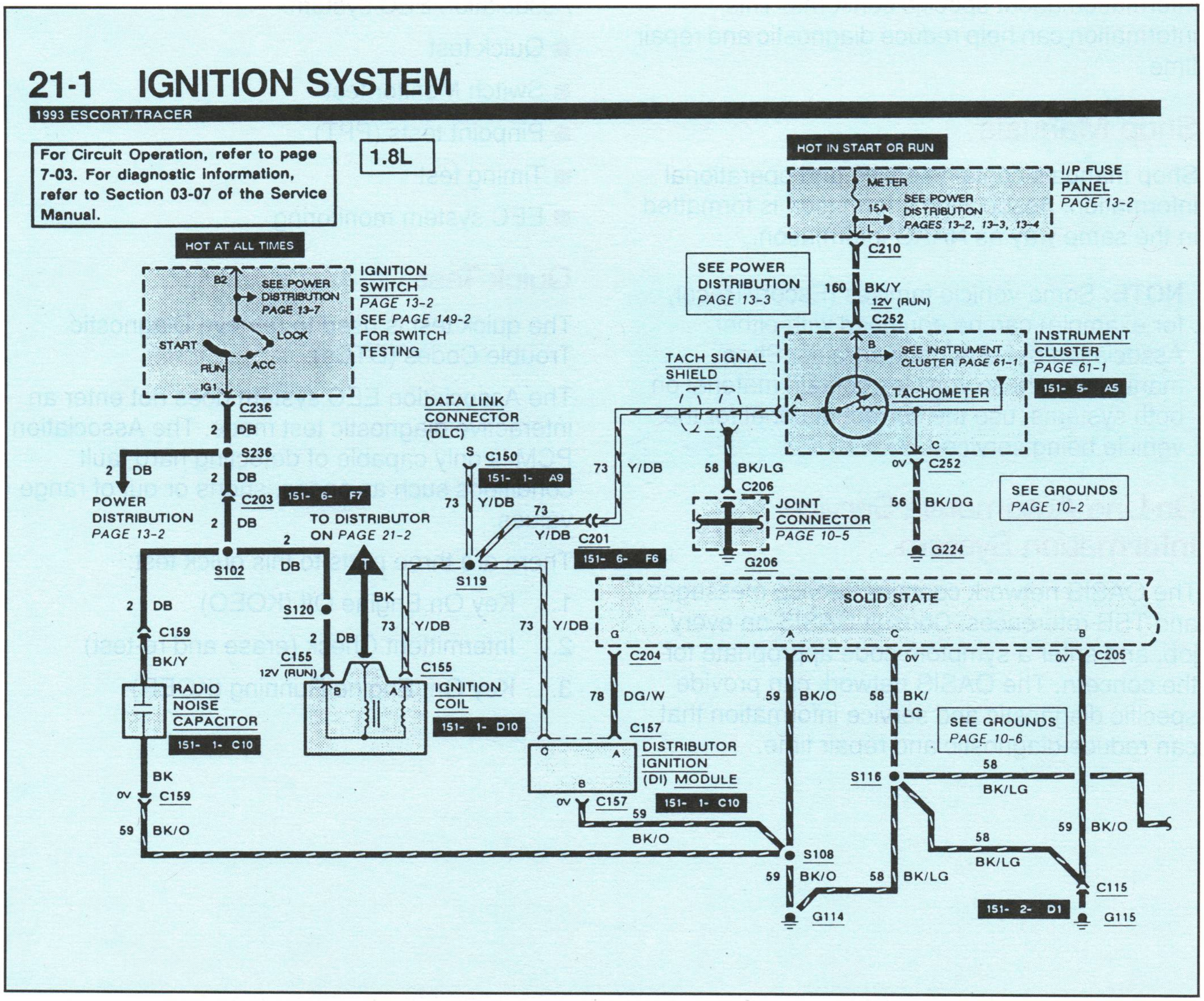


Figure 10-15 — EVTM 1.8L ignition schematic – Association application

EVTMs contain electrical schematics, component location indexes and system operational information.

NOTE: Some vehicle families (Escort/Tracer, for example) can be equipped with either Association or NAAO powertrains. EVTMs for these vehicles contain material on both systems. Use the correct material for the vehicle being serviced.

DI – ELECTRONICALLY CONTROLLED TIMING

Technical Service Bulletins

TSB articles contain diagnostic and service information about specific concerns. This information can help reduce diagnostic and repair time.

Shop Manuals

Shop manuals contain service and operational information. Association information is formatted in the same way as NAAO information.

NOTE: Some vehicle families (Escort/Tracer, for example) can be equipped with either Association or NAAO powertrains. Shop manuals for these vehicles contain material on both systems. use the correct material for the vehicle being serviced.

On-Line Automotive Service Information System

The OASIS network contains service messages and TSB references. Consult OASIS on every job, and enter a symptom code appropriate for the concern. The OASIS network can provide specific diagnostic and service information that can reduce diagnostic and repair time.

DIAGNOSTIC TESTS

The following tests are performed on the Association EEC system:

- Quick test
- Switch Monitor test
- Pinpoint tests (PPT)
- Timing test
- EEC system monitoring

Quick Test

The quick test is used to retrieve Diagnostic Trouble Codes (DTCs).

The Association EEC system does not enter an interactive diagnostic test mode. The Association PCM is only capable of detecting hard fault conditions such as opens, shorts or out of range values.

There are three parts to this quick test:

1. Key On Engine Off (KOEO)
2. Intermittent Check (erase and re-test)
3. Key On, Engine Running (KOER)

KEY ON ENGINE OFF TEST

Diagnostic Trouble Code	Component
01	Ignition Diagnostic Monitor
02	CKP Sensor
03	CID Sensor
04	CKP Sensor
05	Knock Sensor
08	Air Flow Meter
09	ECT Sensor
10	IAT Sensor
11	IAT Sensor
12	TP Sensor
14	BARO Sensor
15	(Heated) Oxygen Sensor
16	EGRT Sensor / EVP Sensor
17	(Heated) Oxygen Sensor
23	Heated Oxygen Sensor
24	Heated Oxygen Sensor
25	FPRC Solenoid
26	CANP Solenoid
28	EVR Solenoid / EGRC Solenoid
29	EGRV Solenoid
34	IAC Solenoid
41	HSIA Solenoid / VRIS1 Solenoid
46	VRIS2 Solenoid
67	LFAN Relay
68	HFAN Relay
69	ECTF Sensor
Codes Not Listed	—

Figure 10-16 — DTC chart

KOEO self test is initiated when the **Self Test Input (STI)** circuit of the PCM is grounded.

There is no system pass DTC. If no faults are detected, no codes will be output. Additionally, the DTCs are currently in a 2-digit format.

INTERMITTENT CHECK — ERASE AND RE-TEST

TEST STEP

ERASE AND RETEST

NOTE: Erasing diagnostic trouble codes and retesting will give an indication whether diagnostic trouble codes received in test step QT4 represent hard or intermittent faults. Hard faults will repeat immediately and codes will be displayed during retest.

- Confirm code(s) were received in test step QT4.
- Turn the SUPER STAR II Tester or VOM OFF, or disconnect the NGS Scan Tool.
- Disconnect the negative battery cable and depress the brake pedal for 5-10 seconds to erase codes in memory.
- Perform the Key ON Engine Off Test as instructed in test step QT4.

  NOTE: If codes retrieved the first time cannot be re-created, it may be necessary to tap suspect sensors, shake and wiggle harness, or drive the vehicle in order to induce a failure. Repeat step QT4 each time.
- **Record the diagnostic trouble codes.**

Figure 10-17 — Erase and retest

DTCs are stored in memory. However, there is no separation between **hard fault** and continuous DTC output. In order to determine if a DTC is a hard fault or memory code, erase the DTCs and re-test. If the DTC returns when re-tested, the DTC is a hard fault. If the DTC does not return, then it is considered a memory DTC. It is important that all DTCs received are written down because they may not return when an erase and re-test procedure is performed. A DTC in memory indicates that a hard fault existed but has corrected itself.

KEY ON ENGINE RUNNING

PERFORM KEY ON ENGINE RUNNING TEST

NOTE: If using the New Generation Star (NGS) Scan Tool, follow the procedure in the appendix to activate and deactivate the Diagnostic Test Mode.

- Deactivate the Diagnostic Test Mode by unlatching the center button on the SUPER STAR II Tester and turning the tester OFF or disconnect the jumper connecting PCM STI to ground.
- Run the engine at 2000 rpm for three minutes.
- If using Super Star II Tester, turn the SUPER STAR II Tester ON.
- Latch the center button on the SUPER STAR II Tester or jumper the PCM STI to ground if using VOM or MIL.
- Turn the engine off.
- Start the engine and run the engine at idle.
- Activate the Diagnostic Test Mode by unlatching and relatching the SUPER STAR II Tester.
- **Record the diagnostic trouble codes.**

Figure 10-18 — KOER self test

The KOER, like the KOEO, test is not an interactive test. The test detects open, shorted and out of range conditions only.

TEST EQUIPMENT

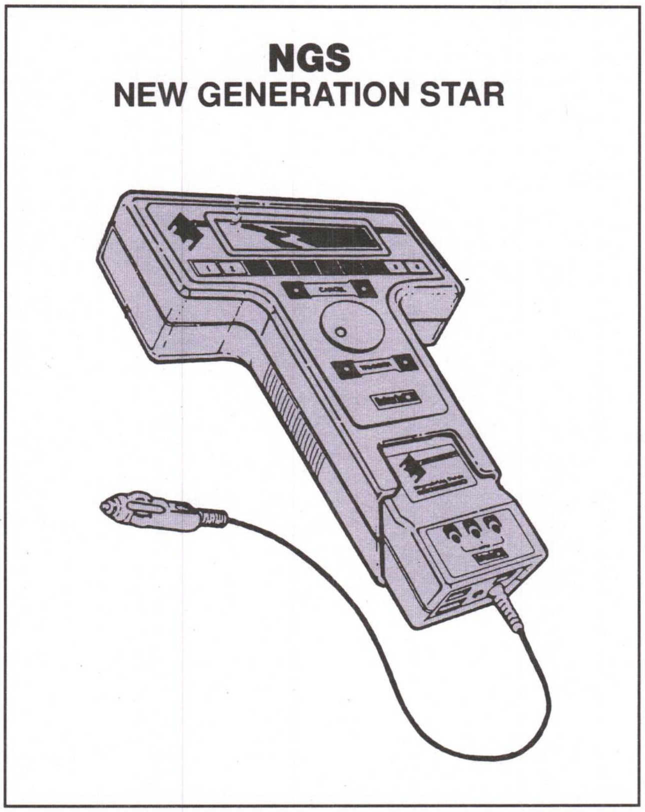

NGS
NEW GENERATION STAR

Figure 10-19 — NGS

The New generation STAR (NGS) tester or Super STAR II is used to perform a quick test on Association vehicles. To perform the test, connect the tester to the vehicle's **Data Link Connector (DLC)**.

NOTE: DTCs can be retrieved using the Malfunction Indicator Lamp (MIL). Refer to "EEC Quick Test Procedures" in the "B" section of the PCED manual for instructions.

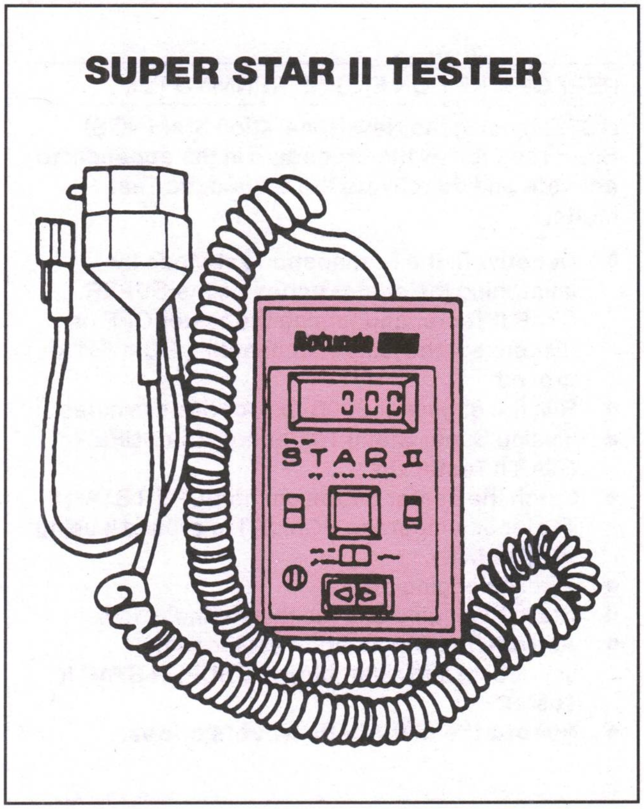

SUPER STAR II TESTER

Figure 10-20 — Super STAR II

NOTE: An adapter is required to connect the testers to the DLC. Refer to "EEC Quick Test Procedures" in the "B" section of the PCED manual when performing a Quick Test.

Switch Monitor Test

The **Switch Monitor Test** checks individual input signals from individual input switches. Some of which include the following:

- **Air Conditioning (A/C)**
- **Brake On-Off (BOO)**
- **Idle Switch (IDL)**

SWITCH MONITOR TEST EQUIPMENT

TEST STEP		RESULT ▶	ACTION TO TAKE
QT9	SWITCH MONITOR TEST CHART		

Switch/Relay	1.3L	1.6L Non-Turbo	1.6L Turbo	1.8L	2.0L 4EAT	2.5L	Condition	Super Star II Tester / NGS Scan Tool LED, or Analog VOM Indication	EEC Pinpoint Test
A/C Selector (ACS) Switch	X	X	X	X	X	X	A/C selector switch on (and blower on for 1.3L, 1.6L and 1.8L)	LED on, or less than 1.5 volts	STG
Blower Motor (BLMT) Switch	X	X	X	X	X	X	Blower switch on 2nd or above position for 1.3L, 1.6L, 1.8L and 3rd or Hi position with mode switch on for 2.0L and 2.5L	LED on, or less than 1.5 volts	STG (ELU for 1.6L)
Brake ON/OFF (BOO) Switch	X	X	X	X MTX	X	X	Brake pedal depressed	LED on, or less than 1.5 volts	STP
Coolant Temperature Switch (CTS)	X	X	X	X			Cooling fan on low speed (ground fan if necessary)	LED on, or less than 1.5 volts	STP (ELU for 1.6L)
Daytime Running Lamp (DRL) Relay (Canada Only)						X	Parking brake released	LED on, or less than 1.5 volts	DRL
Headlamp (HDLP) Switch	X	X	X	X	X	X	Headlamp switch on	LED on, or less than 1.5 volts	STP (ELU for 1.6L)
High Cooling Fan (HFAN) Relay					X	X	Accelerator pedal depressed (fan should operate at high speed)	LED on, or less than 1.5 volts	ROC
Idle (IDL) Switch	X	X	X	X	X	X	Accelerator pedal depressed	LED on, or less than 1.5 volts	STG
Knock Control (KC)			X				Tap on engine lift bracket while engine running	LED on, or less than 1.5 volts	KC
Low Cooling Fan (LFAN) Relay					X		A/C selector switch on (fan should operate at low speed)	LED on, or less than 1.5 volts	ROC

Figure 10-21 — Switch monitor test

The switch monitor test is performed with the NGS (or STAR II). To perform a Switch Monitor Test activate various switches, and look for a response which will be displayed on the tester. The "Quick Test Procedures" section in the PCED manual ("B" section) contains instructions for performing a Switch Monitor test.

Pinpoint Tests

TEST STEP		RESULT ▶	ACTION TO TAKE
CID1	CHECK CID SIGNAL • Key OFF. • Install breakout box (connect PCM). • Measure the voltage at Test Pin CID while bumping starter. • **Does the voltage alternate between approximately 0 volts and 5 volts?**	Yes ▶	CID circuit OK. If sent to this test by Quick Test Step QT11, RETURN to Diagnostic Routines. Otherwise, REPLACE the PCM.
		No ▶	GO to CID2.
CID2	CHECK VPWR TO DISTRIBUTOR • Key OFF. • Disconnect the distributor connector. — 1.8L 4-pin connector — 2.0L 4EAT 6-pin connector — 2.5L 6-pin connector • Key ON. • Measure the voltage at the VPWR wire on the distributor harness connector. • **Is the voltage greater than 10 volts?**	Yes ▶	GO to CID3.
		No ▶	GO to EEC Pinpoint Test VPWR. If VPWR is OK, SERVICE VPWR wire to distributor.
CID3	CHECK GROUND AT DISTRIBUTOR • Key OFF. • Disconnect the distributor connector. — 1.8L 4-pin connector — 2.0L 4EAT 6-pin connector — 2.5L 6-pin connector • Measure the resistance of the GND wire between the distributor harness connector and ground. • **Is the resistance less than 5 ohms?**	Yes ▶	GO to CID4.
		No ▶	SERVICE the distributor GND wire.

Figure 10-22 — Typical CID pinpoint test

PPTs are found in the "EEC Pinpoint Test Procedures" section in the PCED manual "B" section. They provide step by step instructions designed to isolate a specific concern. Perform PPTs only when instructed to do so by the PCED manual.

PINPOINT TEST EQUIPMENT

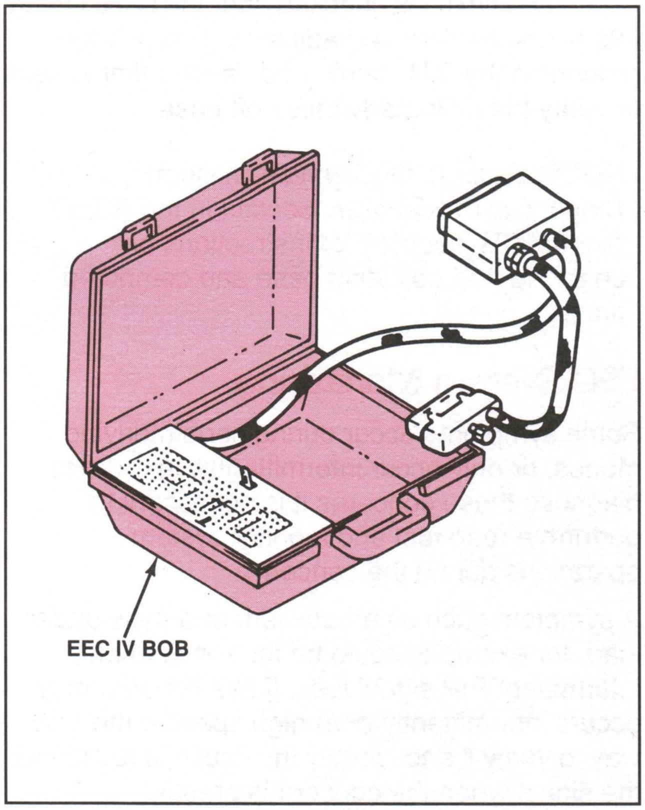


Figure 10-23 — EEV IV BOB

The EEC IV BOB and a DVOM are used to perform PPTs on Association vehicles. PPTs for Association vehicles are similar to PPTs on NAAO vehicles. These tests are designed to isolate concerns within specific circuits. The BOB allows you to access PCM pins from one location. To use the EEC IV BOB on an Association vehicle, an adapter is necessary. Refer to the PCED manual for tool requirements.

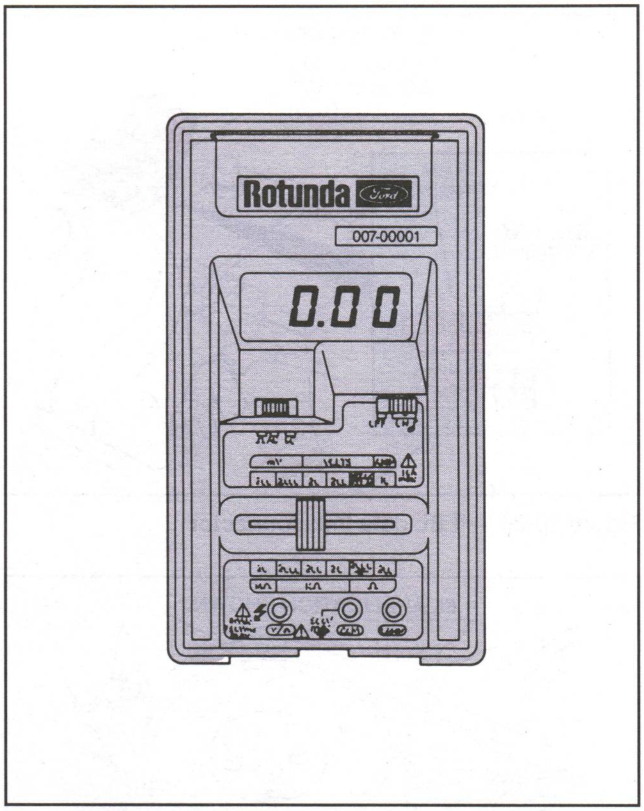


Figure 10-24 — DVOM

Timing Tests

There are two spark timing checks:

- Base Timing
- Computed Timing

BASE TIMING

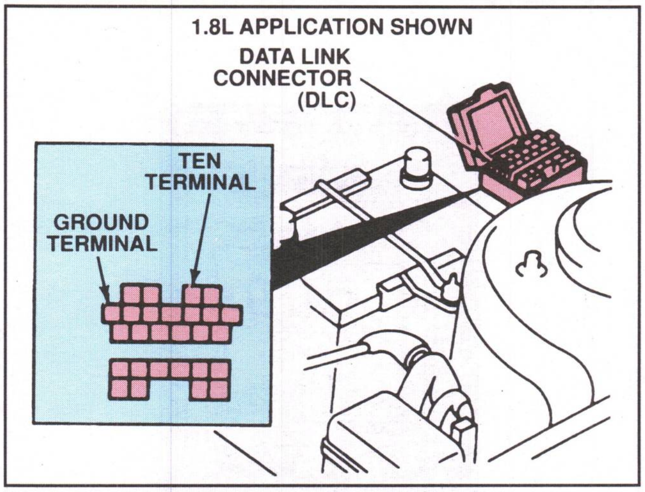


Figure 10-25 — 1.8L data link connector

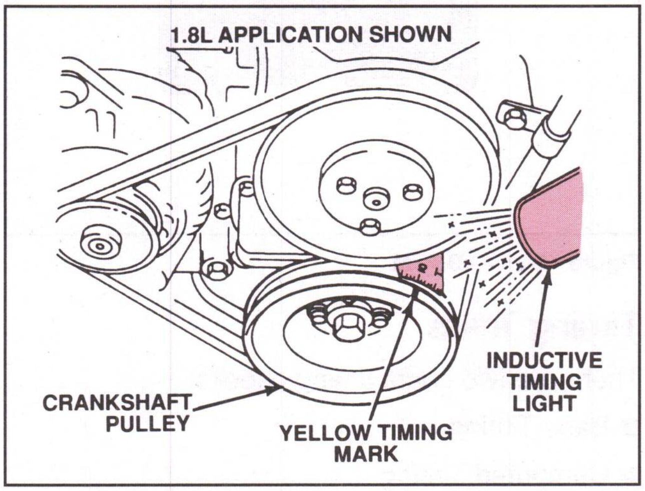


Figure 10-26 — 1.8L timing marks

To perform a base timing check perform two basic steps:

1. Put the PCM in the self test mode by grounding the STI circuit. This is done to keep the timing fixed at base.
2. Run the engine at idle and use a timing light to check the timing.

COMPUTED TIMING

Computed timing is checked after the base timing has been checked and adjusted. Discontinue grounding the STI circuit, and use the timing light to verify the timing advances off base.

NOTE: Refer to the "Ignition System Diagnostic Procedures" section in the PCED manual ("B" section) for instructions on checking and adjusting base and computed timing.

EEC System Monitoring

Some symptoms occur during certain driving modes, or only occur intermittently. In order to diagnose these concerns it is necessary to perform a road test and monitor system operations during the concern.

A symptom such as a buck/jerk or a miss under load, for example, could be the result of an intermittent PIP signal loss. If this concern only occurs intermittently or at high speeds, the only way to verify it and identify the cause is to monitor the signal when the concern is present.

Symptoms that occur intermittently, or only during specific driving modes, can be difficult to diagnose. Monitoring system operations help, but you must have an understanding of the relationships between symptoms, conditions and systems/components in order to know what to look for.

TEST EQUIPMENT

The EEC IV monitor, recorder and EEC IV BOB are used to monitor the EEC system.

NOTE: Refer to the PCED manual "Intermittent Fault Diagnosis" section for information on the vehicle's EEC system.

NOTE: Always exercise proper safety precautions when performing monitor diagnostic procedures. If road testing is necessary, have an assistant drive the vehicle while you watch the monitoring equipment.

EEC IV MONITOR

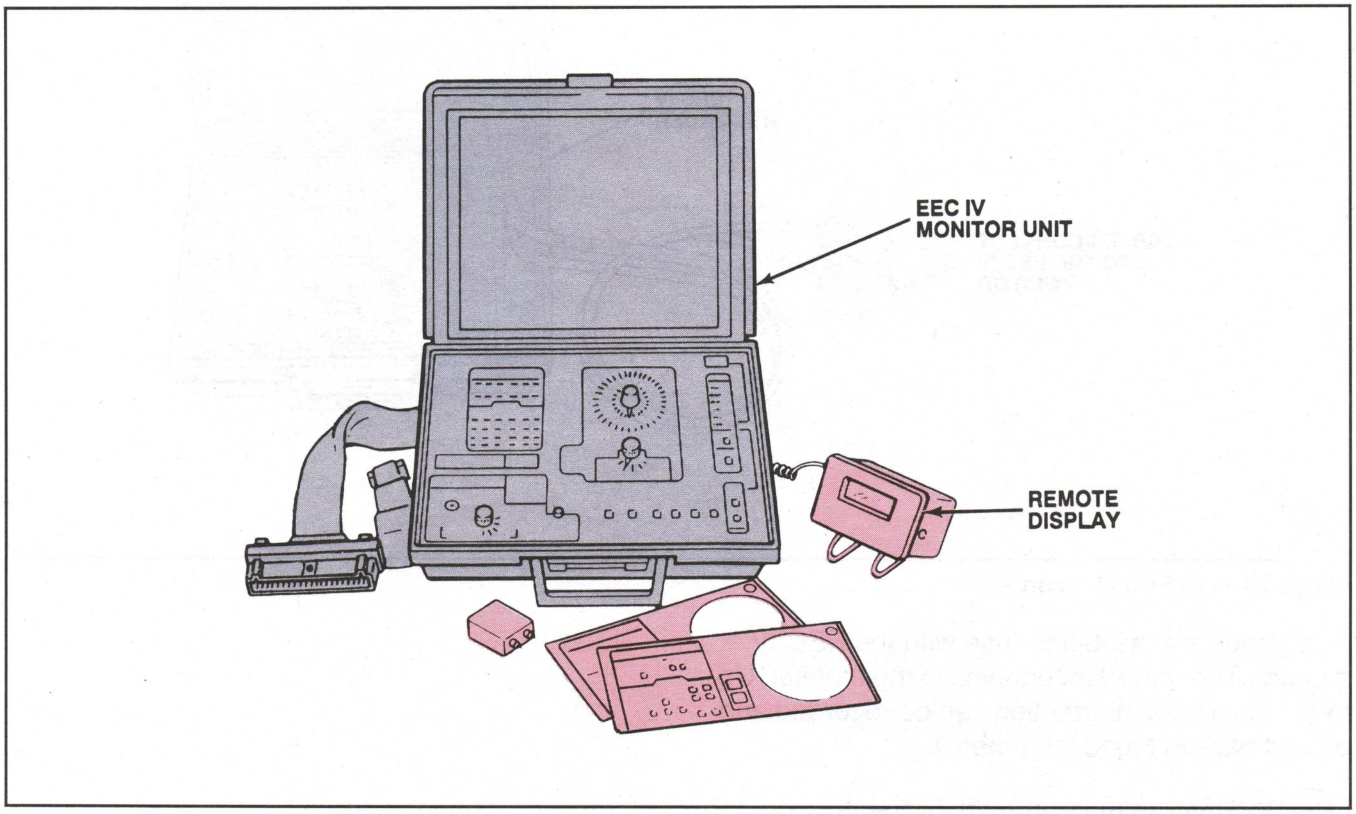


Figure 10-27 — EEC IV monitor

The EEC IV monitor is connected to the PCM using an adapter cable. When connected to the PCM, the monitor displays PCM values on the remote display. The ignition related signals that can be monitored are the PIP, CID and SPOUT signals.

NOTE: The "Intermittent Fault Diagnosis" section in the PCED manual contains information on monitoring EEC systems and using the EEC IV Monitor. Additional instructions on using the EEC IV Monitor is available in the EEC IV Monitor manual.

RECORDER

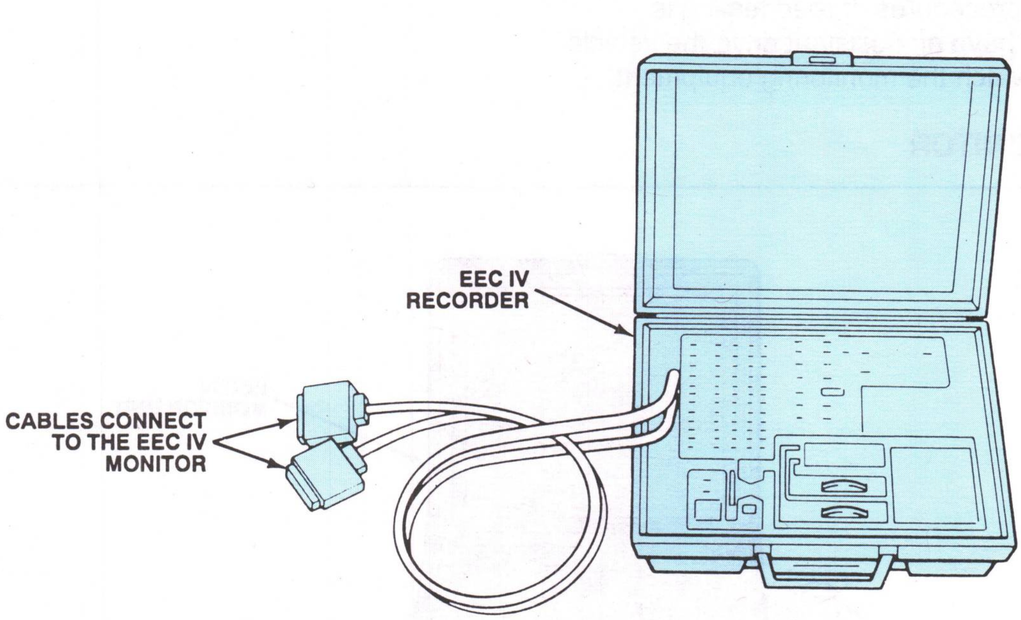


Figure 10-28 — EEC IV recorder

A recorder is available for use with the EEC IV monitor. The recorder connects to the monitor. Up to 8 channels of information can be recorded and played back in timed increments.

NOTE: Refer to the "Intermittent Fault Diagnosis" section of the PCED manual, or the EEC IV Monitor manual, when using the recorder and monitor.

EEC IV BOB

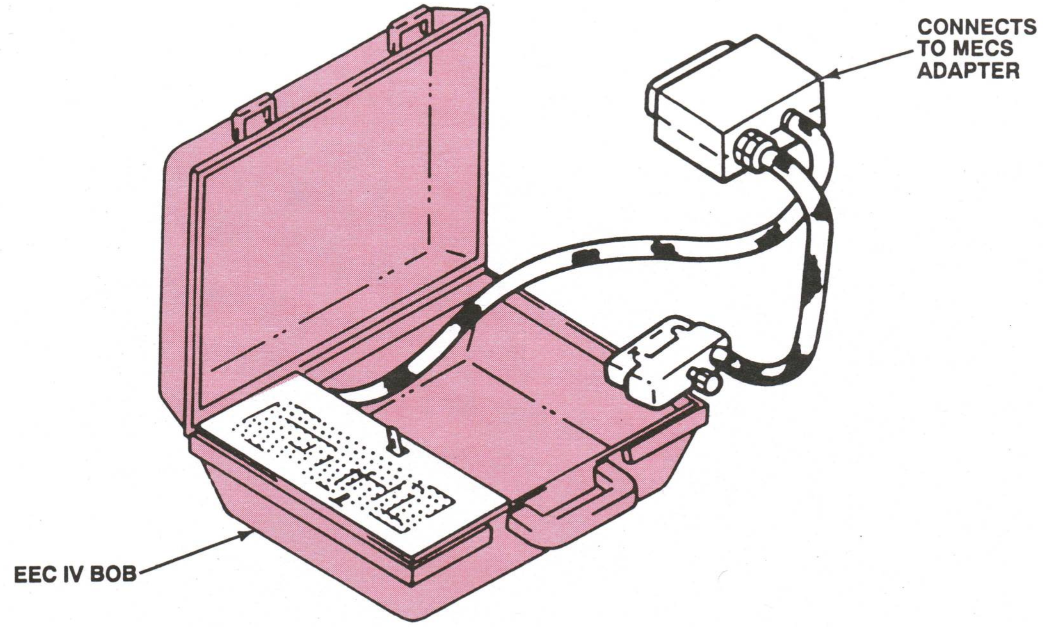


Figure 10-29 — EEC IV BOB

The EEC IV BOB is used along with a DVOM and connects to the PCM with an adapter cable. PCM circuits are monitored with a DVOM while the vehicle is being operated.

NOTE: Refer to the “Intermittent Fault Diagnosis” section in the PCED manual when monitoring the EEC system.

This is the end of Lesson 10. Now view Lesson 10 on the video tape then answer the Progress Check questions.

LESSON 10 – PROGRESS CHECK QUESTIONS

The following questions are based on the information contained in Lesson 10. Choose the **ONE** best correct answer. The answers are provided on the following page. Review any questions missed before proceeding to the next lesson.

1. Technician A says an optical sensor sends a signal as a rotating disc passes between an LED and a phototransistor. Technician B says an ignition system optical sensor produces a square wave signal with an amplitude between 0 and 5.0 volts. Who is correct?
   A. Technician A
   B. Technician B
   C. Both A and B
   D. Neither A nor B

2. Technician A says that there is an ignition configuration that uses two CKP sensors. Technician B says there is an ignition configuration that uses Hall effect and magnetic pick-up type sensors rather than optical type sensors. Who is correct?
   A. Technician A
   B. Technician B
   C. Both A and B
   D. Neither A nor B

3. Technician A says the primary and secondary ignition sub-systems on association vehicles are similar to the primary and secondary sub-systems found in NAAO vehicles with DI systems. Technician B says the ignition coils used on association vehicles operate differently than the coils used on NAAO DI vehicles. Who is correct?
   A. Technician A
   B. Technician B
   C. Both A and B
   D. Neither A nor B

DI – ELECTRONICALLY CONTROLLED TIMING

LESSON 10 – PROGRESS CHECK ANSWERS

1. Technician A says an optical sensor sends a signal as a rotating disc passes between an LED and a phototransistor. Technician B says an ignition system optical sensor produces a square wave signal with an amplitude between 0 and 5.0 volts. Who is correct?

A. Technician A

B. Technician B

[✓ C.] Both A and B

D. Neither A nor B

An optical sensor produces a square wave signal with an amplitude between 0 and 5.0 volts as a rotating disc passes between the LED and phototransistor.

2. Technician A says that there is an ignition configuration that uses two CKP sensors. Technician B says there is an ignition configuration that uses Hall effect and magnetic pick-up type sensors rather than optical type sensors. Who is correct?

A. Technician A

B. Technician B

[✓ C.] Both A and B

D. Neither A nor B

The third configuration, discussed in the lesson, uses two CKP sensors, called CKP1 and CKP2. They are Hall effect and magnetic pick-up type sensors respectively.

3. Technician A says the primary and secondary ignition sub-systems on association vehicles are similar to the primary and secondary sub-systems found in NAAO vehicles with DI systems. Technician B says the ignition coils used on association vehicles operate differently than the coils used on NAAO DI vehicles. Who is correct?

[✓ A.] Technician A

B. Technician B

C. Both A and B

D. Neither A nor B

The primary and secondary ignition sub-systems found on Association and NAAO vehicles are very similar. The ignition coils used on association vehicles have physical differences and may be mounted differently than NAAO applications, however, they operate the same way. Both have primary and secondary windings. Both produce high secondary voltage through magnetic induction.

LESSON 10 – PROGRESS CHECK QUESTIONS (CONT'D.)

4. Where will you find diagnostic information about the EEC system used on Association vehicles?
   - A. The "A" sections of the PCED manual.
   - B. The "B" sections of the PCED manual.
   - C. The Mazda Powertrain shop manual.
   - D. Individual vehicle shop manuals.

5. Technician A says that a DTC 11 will be displayed during a KOEO self test if the system passes. Technician B says that if no codes are output during a KOEO self test there could be a problem with the data communications link, the tester or the PCM. Who is correct?
   - A. Technician A
   - B. Technician B
   - C. Both A and B
   - D. Neither A nor B

6. Technician A says a switch monitor test is performed to check individual input signals. Technician B says he can perform a switch monitor test on a Association EEC system using either the NGS or super STAR II testers. Who is correct?
   - A. Technician A
   - B. Technician B
   - C. Both A and B
   - D. Neither A nor B

7. Technician A says you should always perform a switch monitor test when performing EEC related diagnostics on Association vehicles. Technician B says it is only necessary to perform a switch monitor test if a DTC was received during KOEO or KOER self tests. Who is correct?
   - A. Technician A
   - B. Technician B
   - C. Both A and B
   - D. Neither A nor B

LESSON 10 – PROGRESS CHECK ANSWERS (CONT'D.)

4. Where will you find diagnostic information about the EEC system used on Association vehicles?

A. The "A" sections of the PCED manual.
[✓ B.] The "B" sections of the PCED manual.
C. The Mazda Powertrain shop manual.
D. Individual vehicle shop manuals.

The "B" sections of the PCED are devoted to Association systems. The "A" sections are devoted to NAAO systems.

5. Technician A says that a DTC 11 will be displayed during a KOEO self test if the system passes. Technician B says that if no codes are output during a KOEO self test there could be a problem with the data communications link, the tester or the PCM. Who is correct?

A. Technician A
B. Technician B
C. Both A and B
[✓ D.] Neither A nor B

No passing DTC's are issued on Association EEC systems. If no faults are detected during a KOEO self test no codes will be output.

6. Technician A says a switch monitor test is performed to check individual input signals. Technician B says he can perform a switch monitor test on an Association EEC system using either the NGS or super STAR II testers. Who is correct?

A. Technician A
B. Technician B
[✓ C.] Both A and B
D. Neither A nor B

The NGS or STAR II testers can be used to check individual input signals by performing a switch monitor test.

7. Technician A says you should always perform a switch monitor test when performing EEC related diagnostics on Association vehicles. Technician B says it is only necessary to perform a switch monitor test if a DTC was received during KOEO or KOER self tests. Who is correct?

[✓ A.] Technician A
B. Technician B
C. Both A and B
D. Neither A nor B

A switch monitor test should always be performed. This diagnostic test can identify EEC related concerns that KOEO and KOER tests can not detect.

LESSON 10 – PROGRESS CHECK QUESTIONS (CONT'D.)

8. Technician A says that the EEC IV monitor and EEC IV BOB can be used to monitor Association EEC operation. Technician B says an adapter harness is needed to use the EEC IV BOB on Association EEC systems but, the EEC IV monitor is not compatible with Association EEC systems under any circumstances. Who is correct?

   A. Technician A

   B. Technician B

   C. Both A and B

   D. Neither A nor B

LESSON 10 – PROGRESS CHECK ANSWERS (CONT'D.)

8. Technician A says that the EEC IV monitor and EEC IV BOB can be used to monitor Association EEC operation. Technician B says an adapter harness is needed to use the EEC IV BOB on Association EEC systems but, the EEC IV monitor is not compatible with Association EEC systems under any circumstances. Who is correct?

   [✓ A.] Technician A
   B. Technician B
   C. Both A and B
   D. Neither A nor B

   Both the EEC IV BOB and EEC IV monitor are good Association EEC system monitoring tools. Both connect to the Association PCM with an adapter harness.

IGNITION SYSTEM THEORY AND OPERATION

Lesson **1** Spark and Ignition

Lesson **2** Basic Ignition

Lesson **3** Ignition Requirements and Operating Modes

Lesson **4** Ignition Related Driveability Symptoms

Lesson **5** Basic Testing

NAAO

Lesson **6** DI Ignition System

Lesson **7** EI – Low Data Rate Ignition System

Lesson **8** EI – High Data Rate Ignition System

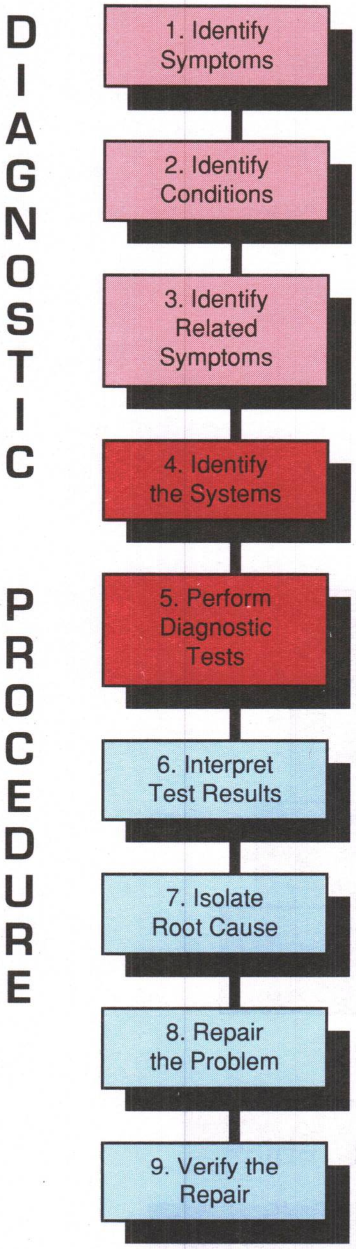
Lesson **9** EEC System Diagnosis

ASSOCIATION

Lesson **10** DI Electronically Controlled Timing

Lesson **11** DI Mechanically Controlled Timing

Lesson **12** Villager DI Ignition System



LESSON 11: DI MECHANICALLY CONTROLLED TIMING

The information in this lesson relates to steps 4 and 5 of the diagnostic procedure. It covers the operation, diagnosis and testing of the DI mechanically controlled timing system used on Association vehicles.

Objective(s):

The information in this lesson will enable you to:

- Identify and describe the operation of the ignition system components and describe their functions in operating as a system.
- Identify and describe ignition system diagnostic procedures and test equipment.

DI – MECHANICALLY CONTROLLED TIMING

APPLICATION

The primary and secondary ignition sub-systems are similar to those found on the other DI systems, previously covered in this course. The difference with this system is that spark timing is controlled mechanically, not electronically.

The only powertrain combinations that use this type of ignition system are the 1.6L **Turbo** and 1.6L **non-turbo** engines. These powertrains are used in the Capri.

The Turbo and Non-Turbo applications share the same primary and secondary systems, but have different timing control configurations. This lesson will cover the primary and secondary systems but will focus on the timing control systems used on these powertrains.

PRIMARY IGNITION

The primary sub-system consists of the following components:

- Ignition Control Module (ICM)
- Cylinder Identification (CID) sensor
- Powertrain Control Module (PCM)
- Coil (primary windings)
- Primary Circuitry

Ignition Control Module

The ICM is located in the distributor. It controls the firing of the coil by switching primary current flow on and off.

CID Sensor

The CID sensor is an optical type sensor located in the distributor. It provides engine speed and crankshaft position information to the PCM.

Powertrain Control Module

For ignition purposes the PCM signals the ICM when to fire the coil based on input from the CID sensor.

NOTE: The signal to the ICM is used to fire the coil, but there is no consideration to spark timing. Timing is controlled mechanically.

Coil

The coil is remotely mounted in the engine compartment and contains primary and secondary windings. It produces high secondary voltage through magnetic induction.

Primary Circuits

Primary circuits carry the low voltage current used by the ignition system.

Secondary Ignition

The secondary sub-system is identical to the secondary sub-system of the DI electronically timed system. It contains the following components:

- Coil
- Distributor cap
- Distributor rotor
- Spark plugs
- Secondary circuits

Each of these components functions the same way as in the other DI systems, previously covered in this course.

TIMING CONTROL 1.6L NON-TURBO

Timing control is accomplished mechanically by the distributor. The distributor is equipped with the following components:

- **Mechanical advance mechanism**
- **Vacuum advance mechanism**

MECHANICAL ADVANCE MECHANISM

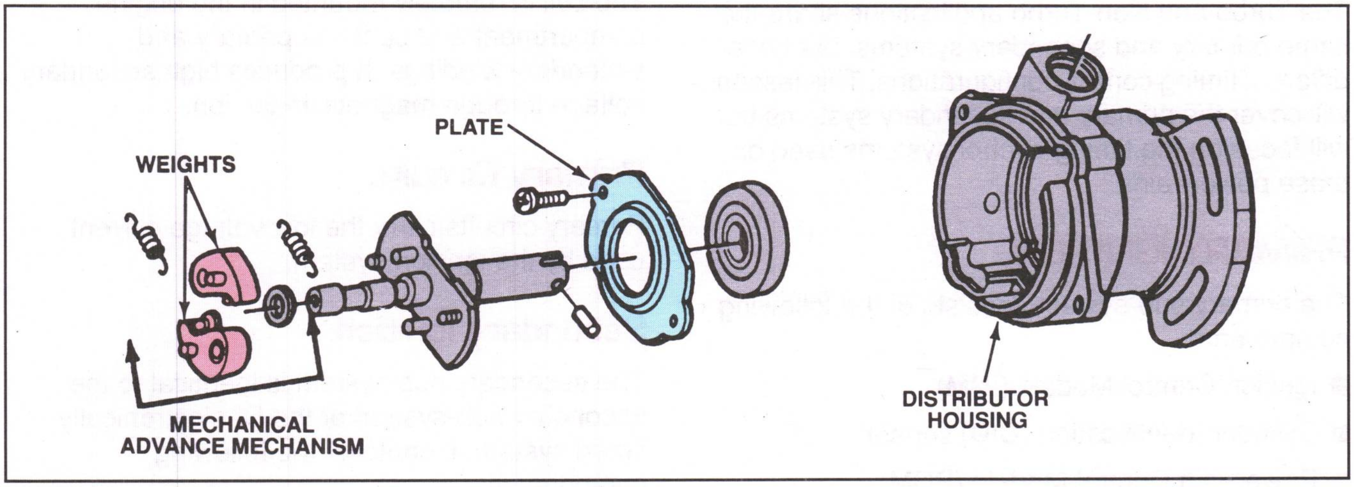


Figure 11-1 — Governor weights

Governor weights are attached to a plate inside the distributor. As engine speed (RPM) increases, these weights move outward and cause the plate to move. This changes the relationship between the CID sensor and the armature of the distributor, causing the ignition signal to advance.

Vacuum Advance Mechanism

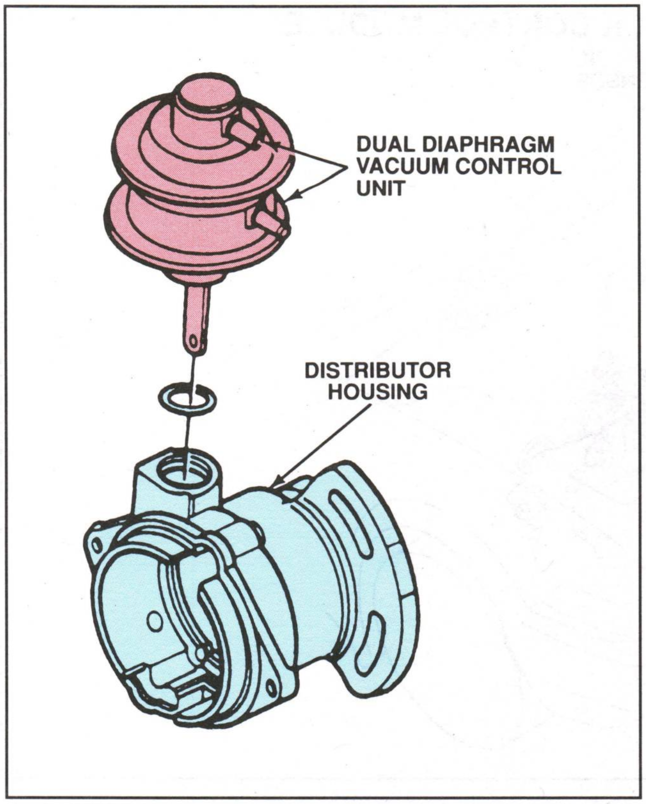


Figure 11-2 — Dual diaphragm vacuum control unit

The vacuum advance unit has two diaphragms and is used to control the amount of spark advance based on engine load. (Manifold vacuum is used to indicate load.) The unit is mounted on the distributor and connects to a movable plate inside the distributor. The vacuum advance unit retards ignition timing when the engine is under load.

A dual diaphragm unit has two vacuum chambers. One provides spark advance and one provides spark retard. This arrangement provides more precise control of ignition timing than a single diaphragm unit.

TIMING CONTROL 1.6L TURBO

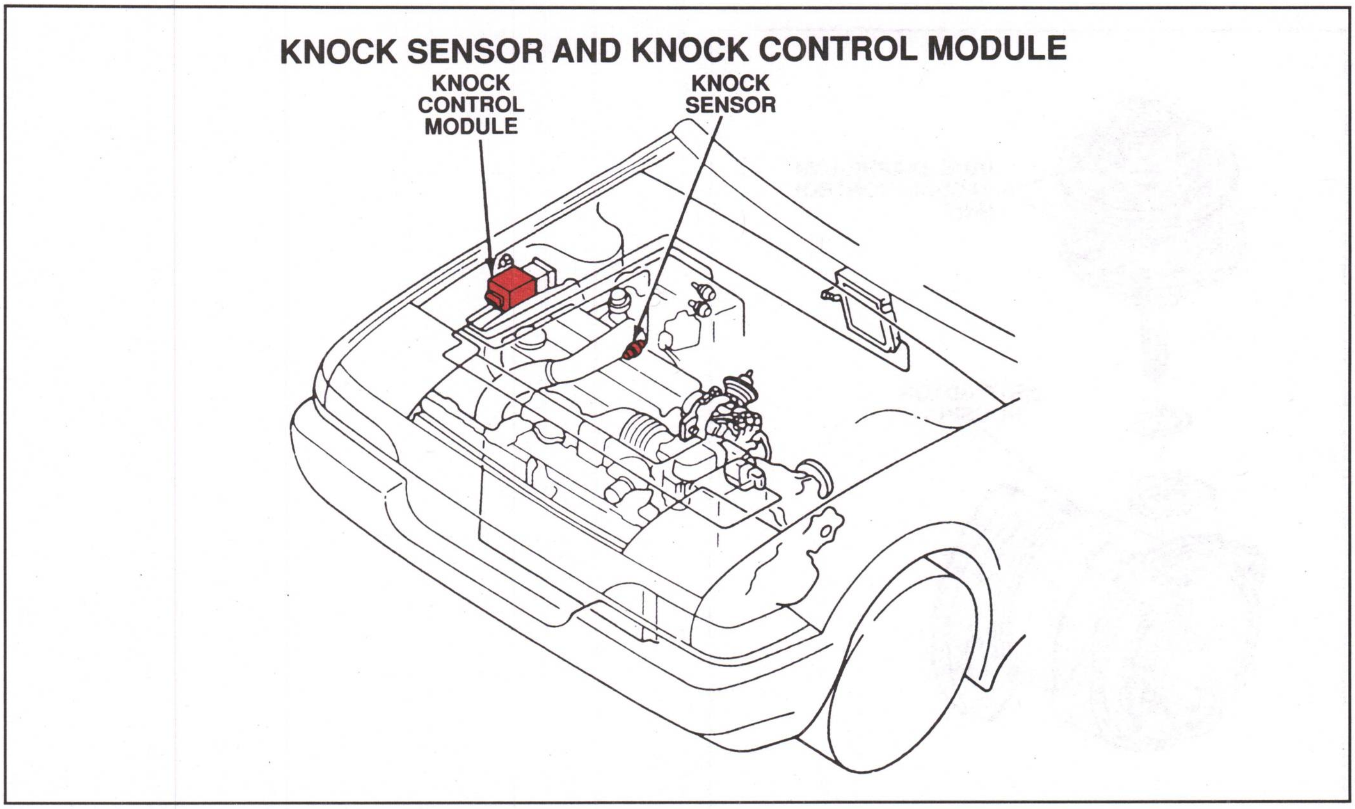


Figure 11-3 — Knock control module and knock sensor

The Turbo application is similar to the Non-Turbo application in that governor weights and a vacuum unit are used for control of spark timing. The vacuum unit used on the Turbo is a single diaphragm unit unlike the Non-Turbo unit which has dual diaphragms. Additionally, spark timing on the Turbo can be influenced electronically. A knock sensor and knock control module combine to influence spark timing in the event of a spark knock condition.

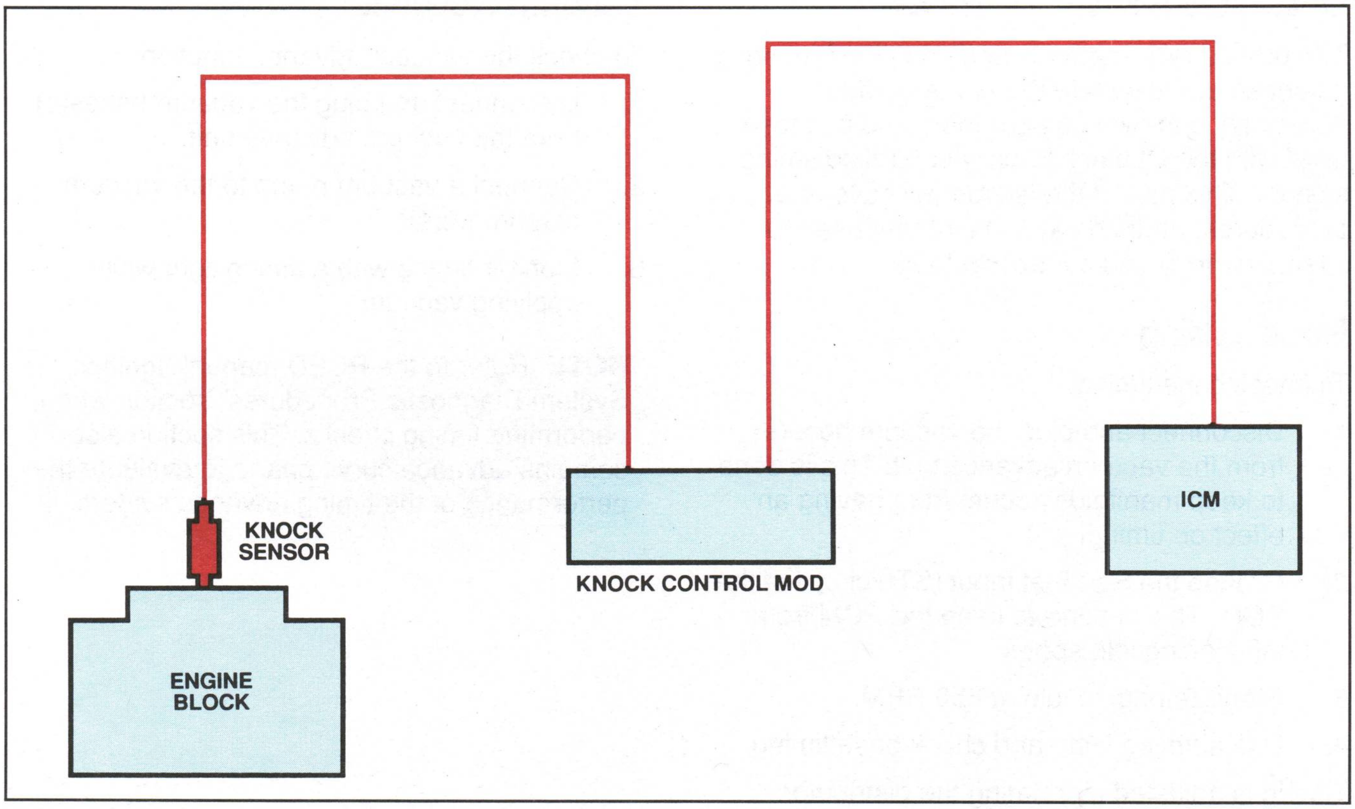


Figure 11-4 — Spark knock control system

Knock Sensor

The knock sensor is mounted in the engine block. When knocking occurs, a voltage is generated, and a signal is sent to the knock control module.

Knock Control Module

The knock control module is remotely mounted in the engine compartment. When the module receives a signal from the knock sensor, it retards the timing according to the intensity of the knock by signaling the ICM. Timing can be retarded to a maximum of 15°.

DIAGNOSIS AND TESTING

The procedures, methods and equipment used to diagnose and evaluate the primary and secondary sub-systems are the same as those used with the DI electronically controlled timing system. This part of the lesson will cover the procedures, methods and equipment used to evaluate the timing control systems.

Base Timing

To check base timing:

1. Disconnect and plug the vacuum hose(s) from the vacuum advance unit. This is done to keep manifold vacuum from having an effect on timing.
2. Ground the Self Test Input (STI) circuit of the PCM. This is done to keep the PCM from influencing idle speed.
3. Stabilize engine idle at 850 RPM.
4. Use a timing light, and check base timing.

Timing is adjusted by rotating the distributor.

Centrifugal Advance

To check centrifugal advance:

1. Disconnect and plug the vacuum hose(s) from the vacuum advance unit.
2. Use a timing light and monitor timing while gradually increasing engine speed.

Timing should advance in relation to increased engine speed.

Vacuum Advance

To check the vacuum advance function:

1. Disconnect and plug the vacuum hoses(s) from the vacuum advance unit.
2. Connect a vacuum pump to the vacuum diaphragm(s).
3. Monitor timing with a timing light while applying vacuum.

NOTE: Refer to the PCED manual “Ignition System Diagnostic Procedures” section when performing timing checks. This section also contains advance curve charts to evaluate the performance of the timing advance system.

This is the end of Lesson 11. Now view Lesson 11 on the video tape then answer the Progress Check questions.

LESSON 11 – PROGRESS CHECK QUESTIONS

The following questions are based on the information contained in Lesson 11. Choose the **ONE** best correct answer. The answers are provided on the following page. Review any questions missed before proceeding to the next lesson.

1. What are the components used to control timing mechanically?
   A. Octane rod
   B. Octane rod and shorting bar
   C. Governor weights and knock control unit
   D. Governor weights and vacuum control unit

2. Technician A says governor weights only advance timing when the engine is under a heavy load. Technician B says timing advance caused by governor weights is often called mechanical advance. Who is correct?
   A. Technician A
   B. Technician B
   C. Both A and B
   D. Neither A nor B

3. Technician A says that the vacuum advance unit is used to provide more spark advance when the engine is under load. Technician B says the vacuum advance unit limits or retards the amount of spark advance when the engine is under load. Who is correct?
   A. Technician A
   B. Technician B
   C. Both A and B
   D. Neither A nor B

LESSON 11 – PROGRESS CHECK ANSWERS

1. What are the components used to control timing mechanically?

   A. Octane rod
   B. Octane rod and shorting bar
   C. Governor weights and knock control unit
   [✓ D.] Governor weights and vacuum control unit

   Governor weights and a vacuum control unit combine to control timing advance functions on the 1.6L engine.

2. Technician A says governor weights only advance timing when the engine is under a heavy load. Technician B says timing advance caused by governor weights is often called mechanical advance. Who is correct?

   A. Technician A
   [✓ B.] Technician B
   C. Both A and B
   D. Neither A nor B

   Governor weights cause timing to advance as engine RPM is increased. This form of timing advance is often called mechanical advance.

3. Technician A says that the vacuum advance unit is used to provide more spark advance when the engine is under load. Technician B says the vacuum advance unit limits or retards the amount of spark advance when the engine is under load. Who is correct?

   A. Technician A
   [✓ B.] Technician B
   C. Both A and B
   D. Neither A nor B

   The vacuum advance unit limits the amount of advance when the engine is under load. When the engine is under load, timing needs to be advanced less than when it is not under load.

LESSON 11 – PROGRESS CHECK QUESTIONS (CONT'D.)

4. Technician A says that the 1.6L turbo can influence timing electronically. Technician B says that the 1.6L turbo has a knock sensor that detects spark knock. Who is correct?
   A. Technician A
   B. Technician B
   C. Both A and B
   D. Neither A nor B

5. Technician A says the methods used to diagnose the primary and secondary ignition sub-systems on the 1.6L engine are the same as those used with other Association vehicle ignition systems. Technician B says that the timing control system on the 1.6L engine is different than the timing control system used on other Association vehicle engines. Who is correct?
   A. Technician A
   B. Technician B
   C. Both A and B
   D. Neither A nor B

6. Technician A says timing is not adjustable on the 1.6L engine. Technician B says it is necessary to disconnect the governor weights to check base timing. Who is correct?
   A. Technician A
   B. Technician B
   C. Both A and B
   D. Neither A nor B

LESSON 11 – PROGRESS CHECK ANSWERS (CONT'D.)

4. Technician A says that the 1.6L turbo can influence timing electronically. Technician B says that the 1.6L turbo has a knock sensor that detects spark knock. Who is correct?

   A. Technician A
   B. Technician B
   [✓ C.] Both A and B
   D. Neither A nor B

   The 1.6L turbo can partially control timing electronically. This is accomplished with the knock sensor and knock control module. The knock sensor detects spark knock and signals the knock control module which will retard timing.

5. Technician A says the methods used to diagnose the primary and secondary ignition sub-systems on the 1.6L engine are the same as those used with other Association vehicle ignition systems. Technician B says that the timing control system on the 1.6L engine is different than the timing control system used on other Association vehicle engines. Who is correct?

   A. Technician A
   B. Technician B
   [✓ C.] Both A and B
   D. Neither A nor B

   The primary and secondary sub-system used on the 1.6L engine is no different than the primary and secondary sub-systems used on other Association vehicles. The only system that is different is the timing control system.

6. Technician A says timing is not adjustable on the 1.6L engine. Technician B says it is necessary to disconnect the governor weights to check base timing. Who is correct?

   A. Technician A
   B. Technician B
   C. Both A and B
   [✓ D.] Neither A nor B

   Timing is adjusted by rotating the distributor. Nothing needs to be done with the governor weights when checking base timing. However, the vacuum lines on the vacuum unit need to be disconnected and plugged.

LESSON 11 – PROGRESS CHECK QUESTIONS (CONT'D.)

7. Technician A says that there is no need to check timing advance functions on the 1.6L engine because the system is controlled mechanically. Technician B says that there is a test for checking mechanical advance, but not for vacuum advance. Who is correct?
   A. Technician A
   B. Technician B
   C. Both A and B
   D. Neither A nor B

8. Technician A says to check mechanical advance, the vacuum hoses on the vacuum advance unit need to be disconnected and plugged. Technician B says to check the vacuum advance, a vacuum pump is used. Who is correct?
   A. Technician A
   B. Technician B
   C. Both A and B
   D. Neither A nor B

LESSON 11 – PROGRESS CHECK ANSWERS (CONT'D.)

7. Technician A says that there is no need to check timing advance functions on the 1.6L engine because the system is controlled mechanically. Technician B says that there is a test for checking mechanical advance, but not for vacuum advance. Who is correct?

   A. Technician A

   B. Technician B

   C. Both A and B

   [✓ D.] Neither A nor B

   Both mechanical and vacuum advance functions can be checked on the 1.6L engine. The PCED manual contains advance curve graphs that indicate the amount of advance that should occur for a particular engine speed.

8. Technician A says to check mechanical advance, the vacuum hoses on the vacuum advance unit need to be disconnected and plugged. Technician B says to check the vacuum advance, a vacuum pump is used. Who is correct?

   A. Technician A

   B. Technician B

   [✓ C.] Both A and B

   D. Neither A nor B

   To check the mechanical advance, the vacuum lines need to be disconnected from the vacuum advance unit so vacuum doesn't influence the timing. To check the vacuum advance function, you use a vacuum pump to apply vacuum to the vacuum unit. This allows you to control the amount of vacuum applied to the unit while you monitor the timing.

IGNITION SYSTEM THEORY AND OPERATION

Lesson **1** Spark and Ignition

Lesson **2** Basic Ignition

Lesson **3** Ignition Requirements and Operating Modes

Lesson **4** Ignition Related Driveability Symptoms

Lesson **5** Basic Testing

NAAO

Lesson **6** DI Ignition System

Lesson **7** EI – Low Data Rate Ignition System

Lesson **8** EI – High Data Rate Ignition System

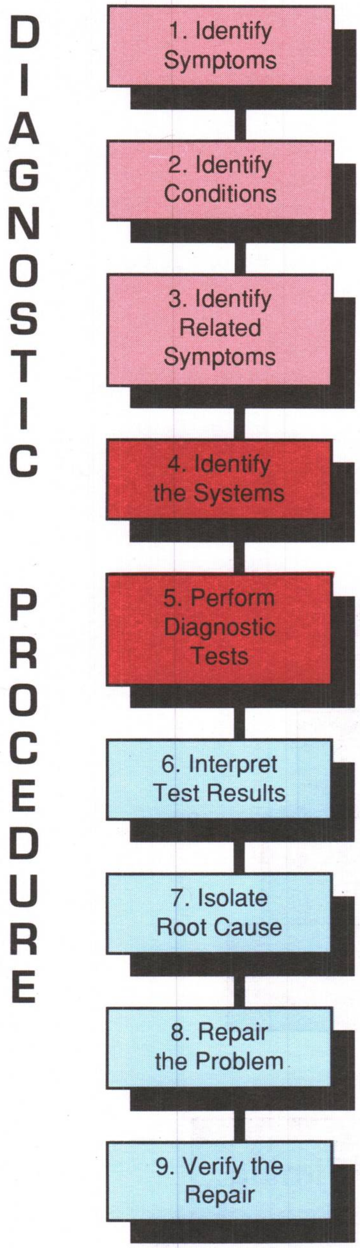
Lesson **9** EEC System Diagnosis

ASSOCIATION

Lesson **10** DI Electronically Controlled Timing

Lesson **11** DI Mechanically Controlled Timing

Lesson **12** Villager DI Ignition System



LESSON 12: VILLAGER DI IGNITION SYSTEM

Where does this lesson fit into the diagnostic procedure?

The information in this lesson relates to steps 4 and 5 of the diagnostic procedure. It covers the operation, diagnosis and testing of the Villager DI system.

The Villager DI ignition system contains primary, secondary and timing control sub-systems; and timing is electronically controlled. This DI system is similar to the other DI systems that control timing electronically.

This lesson will cover primary, secondary and timing control sub-system operation, diagnosis and testing.

Objective(s):

The information in this lesson will enable you to:

- Identify and describe the operation of the ignition system components and describe their functions in operating as a system.
- Identify and describe ignition system diagnostic procedures and test equipment.

NOTE: Many aspects of this DI system are similar to the other DI systems previously covered in this course. As a result, this lesson will only focus on those areas of operation and diagnosis that are unique.

PRIMARY IGNITION

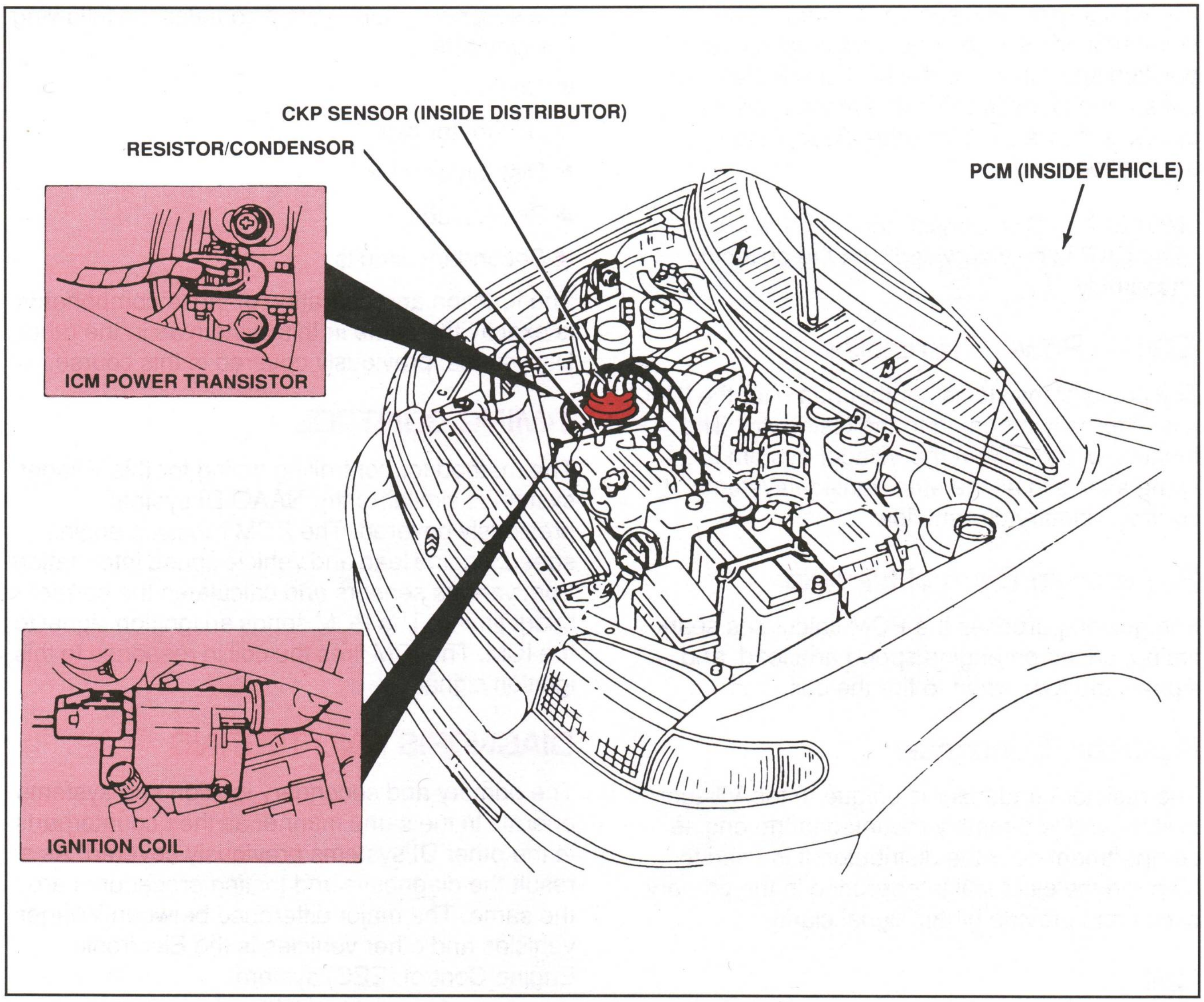


Figure 12-1 — Villager primary ignition components

The following components make up the primary ignition sub-system:

- Crankshaft Position (CKP) sensor
- Ignition Control Module (ICM) — Power Transistor
- Powertrain Control Module (PCM)
- Resistor/condenser
- Coil
- Primary circuits

Crankshaft Position Sensor

An optical type CKP sensor, located in the distributor, is used to send engine speed and position information to the ICM and PCM. The sensor functions in the same manner as the optical sensors used on other Association applications.

NOTE: The CKP sensor cannot be serviced. The CKP is only serviced with the distributor assembly.

ICM — Power Transistor

The power transistor is another name for the ICM. It is externally mounted to the distributor. The function of the ICM in the Villager system is the same as it is in all the other ignition systems. It controls primary current flow.

Powertrain Control Module

For ignition purposes the PCM calculates spark timing, based on engine speed and load, and signals the ICM when to fire the coil.

Resistor/Condenser

The resistor/condenser is unique to the Villager system and is remotely mounted in the engine compartment near the distributor. It is used to help reduce electrical interference in the primary circuit and provide better signal clarity.

Coil

The coil is remotely mounted in the engine compartment and contains primary and secondary windings. It produces high secondary voltage through magnetic induction.

Primary Circuits

The primary circuits carry the low voltage current used by the ignition system. They include circuits for the following components:

- ICM
- PCM
- Coil — primary circuit
- Resistor/Condenser
- CKP Sensor

SECONDARY IGNITION

The secondary sub-system contains the following components:

- Coil
- Distributor cap
- Distributor rotor
- Spark plugs
- Secondary circuits

The function and operation of these components is exactly the same in this system as in the other DI systems, previously covered in this course.

TIMING CONTROL

The method for controlling timing for this Villager system is similar to the NAAO DI system previously covered. The PCM receives engine speed, engine load and vehicle speed information from various sensors and calculates the correct spark timing. The PCM sends an ignition signal to the ICM. The ICM fires the coil in response to this ignition signal.

DIAGNOSIS AND TESTING

The primary and secondary ignition sub-systems operate in the same manner as their counterparts in the other DI systems previously covered. As a result the diagnostic and testing procedures are the same. The major difference between Villager vehicles and other vehicles is the Electronic Engine Control (EEC) system.

The function of the EEC system in the Villager vehicle is the same as other EEC systems. However, there are differences with operating strategies and diagnostic techniques. The following information will concentrate on the testing and diagnostic techniques that are unique.

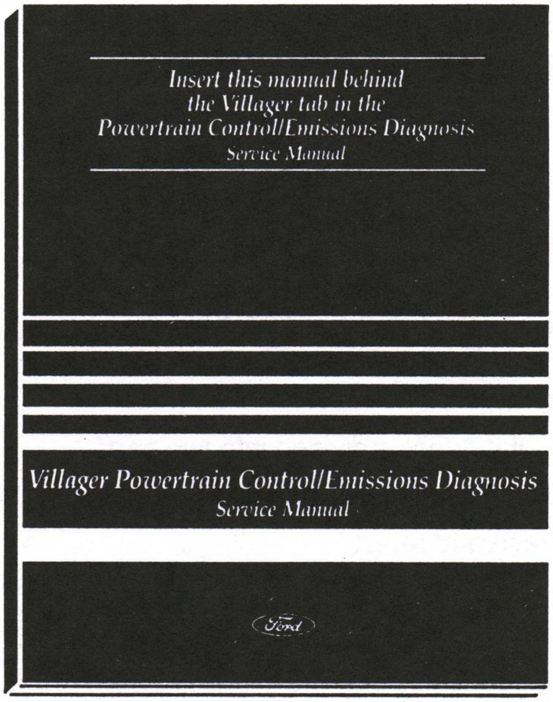
DIAGNOSTIC RESOURCES

Diagnostic and service resources for Villager vehicles include the following:

- Powertrain Control/Emissions Diagnosis (PCED) Manual
- Electrical Vacuum Troubleshooting Manuals (EVTMs)
- Technical Service Bulletins (TSBs)
- Shop Manuals
- On-Line Automotive Service Information System (OASIS)

These resources are familiar to you; they are used for NAAO and Association vehicles. The only resource that is different is the PCED manual.

Powertrain Control/Emissions Diagnosis Manual



Insert this manual behind the Villager tab in the Powertrain Control/Emissions Diagnosis Service Manual

Villager Powertrain Control/Emissions Diagnosis Service Manual

Figure 12-2 — Villager PCED Manual

The PCED manual provides Villager diagnostic and operational information about the EEC and ignition systems in the same way it provides this information on NAAO and Association systems. The difference is the information is contained in a stand alone manual, which should be inserted in the main PCED manual behind the Villager tab.

DIAGNOSTIC TESTS

The following tests are performed on the Villager EEC system:

- Quick test
- Switch Monitor test
- Pinpoint tests (PPTs)
- Timing test
- EEC System monitoring

Quick Test

The quick test is used to retrieve DTC's. The format in which DTC's are retrieved and output are very similar to the other Association EEC systems.

The Quick Test is divided into two parts:

- KOEO Diagnostic Test Mode
- Erase and retest

KOEO

DIAGNOSTIC TROUBLE CODE CHART

DIAGNOSTIC TROUBLE CODE	COMPONENT
11	CRANKSHAFT POSITION (CKP) SENSOR
12	MASS AIR FLOW (MAF) SENSOR
13	ENGINE COOLANT TEMPERATURE (ECT) SENSOR
14	VEHICLE SPEED SENSOR (VSS)
21	IGNITION SIGNAL (IGNS)
31	PCM
32	EXHAUST GAS RECIRCULATION CONTROL (EGRC) SOLENOID
33	HEATED OXYGEN SENSOR (HO2S)
34	KNOCK SENSOR (KS)
35	EXHAUST GAS RECIRCULATION TEMPERATURE (EGRT) SENSOR
43	THROTTLE POSITION (TP) SENSOR
45	INJECTOR LEAK (INJL)
51	INJECTOR SIGNAL (INJS)
55	

Figure 12-3 — DTC chart

The KOEO Diagnostic Test Mode is a function of the PCM. When in this mode the PCM performs self diagnostics and can detect faults. When faults are detected Diagnostic Trouble Codes (DTCs) are output. DTCs refer to specific circuit, or system, faults. A DTC 55 indicates a system pass.

ERASE AND RETEST

ERASE AND RETEST

NOTE: Erasing and retesting will give an indication if the diagnostic trouble codes received in test step QT4 are hard or intermittent faults. Hard faults will be repeated immediately and codes will be displayed during retest.

NOTE: If codes retrieved the first time cannot be re-created, it may be necessary to tap suspect sensors, and shake or wiggle harness in order to induce a failure. Repeat Test Step QT4 each time.

- Confirm code(s) were received in test step QT4.
- Erase the codes in memory. Refer to the Appendix later in this section.
- Perform the Diagnostic Test Mode as instructed in Test Step QT4.
- **Record the trouble codes.**

Figure 12-4 — Erase and retest

This system does not differentiate between hard fault and memory DTC's. If a DTC is received during the KOEO test, you perform an "Erase and Retest" to determine if the DTC is a hard fault.

TEST EQUIPMENT

The New Generation STAR (NGS) or vehicle Malfunction Indicator Lamp (MIL) will display DTCs. To use the NGS use an adapter cable and connect the tester to the vehicle's DLC. To retrieve DTCs using the MIL, use a jumper wire to jump two terminals in the DLC.

NOTE: Refer to the "Quick Test Procedures" section in the Villager PCED manual when performing a quick test.

Switch Monitor Test

PERFORM SWITCH MONITOR TEST

- The Switch Monitor Test checks input signals from the individual input switches to the EEC system's PCM.
- Turn the key ON.
- **If using NGS Scan Tool:**
  - — Select ENGINE.
  - — Select DATA MONITOR AND RECORD.
  - — Select the switches listed in QT8.
  - — Check the switches ON-OFF operation.
- **If using Rotunda Breakout Box 007-00033:**
  - — Key OFF.
  - — Install the Rotunda Breakout Box 007-00033, or equivalent with the Rotunda Breakout Box Adapter 007-00053 (leave the PCM connected).
  - — Key ON.
  - — Measure the voltage for each switch at the specified BOB Pin.
- **Exercise all switches listed in QT8 and record the results.**

Figure 12-5 — Switch monitor test

The Switch Monitor Test checks individual input signals from individual switches. Some of which include the:

- Power Steering Pressure Switch (PSPS)
- Idle Switch (IDL)
- Park/Neutral Position (PNP)

The Switch Monitor Test is performed using the NGS or EEC IV breakout box (BOB).

NEW GENERATION STAR TESTER

The NGS is connected to the vehicle's DLC in the same manner as for Quick Test. Once connected, activate the various switches, and look for a response on the NGS.

EEC IV BOB

When using the EEC IV BOB to perform a Switch Monitor Test, connect the BOB to the PCM. Use a DVOM to measure voltages for each switch at the appropriate pin.

NOTE: An adapter cable is required to connect the BOB to the Villager PCM.

NOTE: Refer to the "Quick Test Procedures" section in the Villager PCED manual for specific instructions when performing a Switch Monitor Test.

Pinpoint Tests

PPTs are in the Villager PCED manual in the "EEC Pinpoint Test Procedures" section. PPTs provide step by step instructions designed to isolate specific concerns. You should only perform PPTs when instructed to do so by the PCED manual.

TEST EQUIPMENT

The EEC IV BOB and/or the NGS are used to perform PPTs. The BOB allows you to access PCM pins to check voltages and resistance. The NGS is capable of accessing the PCM's data stream.

Timing Test

Very specific instructions must be followed to correctly check base timing. Refer to the "Ignition System Diagnostic Procedures" section in the Villager PCED manual.

EEC Monitor Test

EEC Monitor tests are performed to isolate intermittent faults, or faults that occur under specific driving modes. The NGS and EEC IV BOB are the tools used to perform monitoring tests.

NEW GENERATION STAR

The NGS can access the PCM's data stream. The NGS will display values from sensors and circuits.

EEC IV BOB

The BOB is used in conjunction with a DVOM. It allows you to measure PCM circuit voltages while the vehicle is being operated.

NOTE: Refer to the "Intermittent Fault Diagnosis" section in the Villager PCED manual when performing EEC monitoring tests.

NOTE: Always exercise proper safety precautions when performing monitor diagnostic procedures. If road testing is necessary have an assistant drive the vehicle while you watch the monitoring equipment.

This is the end of Lesson 12. Now view Lesson 12 on the video tape and answer the Progress Check questions.

LESSON 12 – PROGRESS CHECK QUESTIONS

The following questions are based on the information contained in Lesson 12. Choose the **ONE** best correct answer. The answers are provided on the following page. Review any questions missed before proceeding to the next lesson.

1. Technician A says that the ignition system used on Villager applications uses an optical type engine speed and position sensor. Technician B says that the Villager system uses a Hall effect type engine speed and position sensor. Who is correct?

   A. Technician A

   B. Technician B

   C. Both A and B

   D. Neither A nor B

2. Technician A says the function of the ICM is to control primary current flow. Technician B says the PCM controls spark timing. Who is correct?

   A. Technician A

   B. Technician B

   C. Both A and B

   D. Neither A nor B

3. Technician A says that the primary and secondary sub-system used in Villager vehicles operates differently than the primary and secondary sub-systems found on other Association vehicles. Technician B says the ignition coil produces high secondary voltage through a process known as phase induction. Who is correct?

   A. Technician A

   B. Technician B

   C. Both A and B

   D. Neither A nor B.

LESSON 12 – PROGRESS CHECK ANSWERS

1. Technician A says that the ignition system used on Villager applications uses an optical type engine speed and position sensor. Technician B says that the Villager system uses a Hall effect type engine speed and position sensor. Who is correct?

   [✓ A. Technician A]
   B. Technician B
   C. Both A and B
   D. Neither A nor B

   The ignition system used on Villager vehicles uses optical type engine speed and position sensors.

2. Technician A says the function of the ICM is to control primary current flow. Technician B says the PCM controls spark timing. Who is correct?

   A. Technician A
   B. Technician B
   [✓ C. Both A and B]
   D. Neither A nor B

   The PCM receives engine speed, position and load information and sends an ignition, or SPOUT, signal to the ICM. The ICM uses this signal to determine when the coil should be fired. The ICM operates the coil by controlling primary current flow.

3. Technician A says that the primary and secondary sub-system used in Villager vehicles operates differently than the primary and secondary sub-systems found on other Association vehicles. Technician B says the ignition coil produces high secondary voltage through a process known as phase induction. Who is correct?

   A. Technician A
   B. Technician B
   C. Both A and B
   [✓ D. Neither A nor B.]

   The primary and secondary sub-systems used on Villager vehicles are very similar to the primary and secondary sub-systems used on other Association vehicles. The ignition coil creates high secondary voltage through a process known as magnetic induction.

LESSON 12 – PROGRESS CHECK QUESTIONS (CONT'D.)

4. Technician A says the Super STAR II can be used to retrieve DTCs on Villager EEC systems, but it cannot access the EEC data stream. Technician B says the only way to retrieve DTCs on a Villager EEC system is by using the NGS. Who is correct?

   A. Technician A

   B. Technician B

   C. Both A and B

   D. Neither A nor B

5. Technician A says a DTC 11 indicates a system pass. Technician B says a DTC 55 is a hard fault code. Who is correct?

   A. Technician A

   B. Technician B

   C. Both A and B

   D. Neither A nor B

LESSON 12 – PROGRESS CHECK ANSWERS (CONT'D.)

4. Technician A says the Super STAR II can be used to retrieve DTCs on Villager EEC systems, but it can not access the EEC data stream. Technician B says the only way to retrieve DTCs on a Villager EEC system is by using the NGS. Who is correct?

A. Technician A
B. Technician B
C. Both A and B
[✓ D.] Neither A nor B

The STAR II tester will not function with Villager EEC systems. The NGS is the best tool for retrieving DTCs. However, DTCs can be retrieved by jumpering terminals in the DLC and counting MIL flashes.

5. Technician A says a DTC 11 indicates a system pass. Technician B says a DTC 55 is a hard fault code. Who is correct?

A. Technician A
B. Technician B
C. Both A and B
[✓ D.] Neither A nor B

A DTC 55 is a passing code on NECS EEC systems. A DTC 11 is a passing DTC on 2-digit NAAO EEC systems.

POST TEST

INTRODUCTION

The Post Test on the following pages is designed to check your performance in the Essentials of Driveability Course.

The Post Test consists of 50 questions. You must correctly answer at least 43 of these questions. This demonstrates that you have mastered this course and that you are qualified for the next course in the Engine Performance Specialty Curriculum.

You may enroll in the hands-on STST only after you have successfully passed the required prerequisite CTP and IVLS courses. Each STST course has a 50 question Pretest. To pass the Pretest and meet the minimum performance requirement, you must correctly answer at least 38 questions.

STARS Technician History File

In the Engine Performance Specialty Curriculum, your performance in each of the CTP courses will be recorded in STARS Technician History file.

Therefore, **you must be registered in STARS before mailing your answer sheet.** Contact your Service Manager now if you are not registered in STARS.

DIRECTIONS FOR COMPLETING POST TEST

1. Remove the self mailer answer sheet located after the last page in this manual.
2. At the top of the self mailer print the following information:
   - Your name and social security number
   - Your dealer's name and the P & A code
   - Course code.
3. Use a pen or pencil to mark your answers on the answer sheet. Circle only the one best correct answer for each question.
4. When you finish the test:
   - Fold and seal the pre-addressed answer sheet.
   - Mail it as soon as possible.

NOTE: This test form will not automatically update or correct records in STARS. If your files need to be updated or corrected, contact your Service Manager.

POST TEST

The following questions are based on the information contained in this course. Choose the ONE best correct answer.

1. Technician A says the length of time that spark is maintained in a combustion chamber is called spark duration. Technician B says the length of time that spark is maintained in a combustion chamber is called spark saturation. Who is correct?

   A. Technician A

   B. Technician B

   C. Both A and B

   D. Neither A nor B

2. Technician A says the ignition coil is the component that converts low voltage into the required high voltage. Technician B says the secondary winding contains many times more windings of wire than the primary winding. Who is correct?

   A. Technician A

   B. Technician B

   C. Both A and B

   D. Neither A nor B

3. Technician A says ignition timing refers to how early or late spark plugs fire in relation to the position of the piston on the compression stroke. Technician B says for the engine to run efficiently and produce low emissions, the combustion process should be completed approximately 10 degrees After Top Dead Center. Who is correct?

   A. Technician A

   B. Technician B

   C. Both A and B

   D. Neither A nor B

4. Technician A says ignition timing requirements can be affected by conditions such as engine load and air/fuel mixtures. Technician B says ignition timing requirements can be affected by conditions such as engine temperature and intake air temperature. Who is correct?

   A. Technician A

   B. Technician B

   C. Both A and B

   D. Neither A nor B

5. Technician A says the TFI Intermittent Tester can be used with CCD DI systems. Technician B says the TFI Intermittent Tester is compatible with CCD DI systems only if it has been updated. Who is correct?

   A. Technician A

   B. Technician B

   C. Both A and B

   D. Neither A nor B

6. Technician A says spark duration is measured in KV. Technician B says spark duration is measured in MS. Who is correct?

   A. Technician A

   B. Technician B

   C. Both A and B

   D. Neither A nor B

7. Technician A says there are more air molecules than fuel molecules in a typical air/fuel mixture. Technician B says there are more fuel molecules than air molecules in a typical air/fuel mixture. Who is correct?

   A. Technician A

   B. Technician B

   C. Both A and B

   D. Neither A nor B

POST TEST

8. Which one of the following applies to both the EI-low data rate and high data rate ignition systems?
   A. Coil packs contain multiple coils.
   B. Only one sensor is used to identify cylinders, crankshaft position and engine RPM.
   C. The same strategy is used to determine ignition timing.
   D. A DPI Circuit is use

9. Technician A says secondary voltage requirements for ignition during starting are lower than for other operating modes. Technician B says richer air/fuel mixtures reduce secondary voltage requirements. Who is correct?
   A. Technician A
   B. Technician B
   C. Both A and B
   D. Neither A nor B

10. Technician A says on a EI-high data rate ignition system the ICM uses the SPOUT signal to determine when to fire the spark plug. Technician B says on a EI-high data rate ignition system the ICM uses the CKP signal to determine which coil to fire. Who is correct?
    A. Technician A
    B. Technician B
    C. Both A and B
    D. Neither A nor B

11. Technician A says rich air/fuel mixtures are easy to ignite because fuel molecules are far apart. Technician B says lean air/fuel mixtures are difficult to ignite because fuel molecules are far apart. Who is correct?
    A. Technician A
    B. Technician B
    C. Both A and B
    D. Neither A nor B

12. Technician A says spark duration is a good indication of ignition strength. Technician B says an ignition system that can produce a spark duration of 1.0 ms or more has enough strength to properly ignite an air/fuel mixture. Who is correct?
    A. Technician A
    B. Technician B
    C. Both A and B
    D. Neither A nor B

13. Technician A says on a EI-low data rate ignition system the ICM does not have to receive a CID signal to start the engine. Technician B says on a EI-low data rate ignition system the engine cannot be started without a CID signal. Who is correct?
    A. Technician A
    B. Technician B
    C. Both A and B
    D. Neither A nor B

14. Technician A says the strength of the magnetic field around the coil depends on the amount of current flowing through the primary winding. Technician B says when coil saturation is obtained the magnetic field is at maximum strength. Who is correct?
    A. Technician A
    B. Technician B
    C. Both A and B
    D. Neither A nor B

POST TEST

15. Technician A says because each combustion process takes about the same amount of time to complete, spark must occur later as engine speed increases. Technician B says because each combustion process takes about the same amount of time to complete, spark must occur sooner as engine speed increases. Who is correct?

    A. Technician A

    B. Technician B

    C. Both A and B

    D. Neither A nor B

16. Technician A says a in-line resistor is used in the IDM circuit on both the DI push start and DI CCD Systems. Technician B says an IDM circuit containing an in-line resistor is used only on a DI push start system. Who is correct?

    A. Technician A

    B. Technician B

    C. Both A and B

    D. Neither A nor B

17. Technician A says when timing retards, spark occurs later on the compression stroke. Technician B says when timing retards, spark occurs earlier on the compression stroke. Who is correct?

    A. Technician A

    B. Technician B

    C. Both A and B

    D. Neither A nor B

18. Technician A says when the DIS harness is connected to the BOB, you have access to many low data rate circuits through the pins of the BOB. Technician B says the EEC IV monitor serves the same purpose as the BOB by allowing you to access many low data rate circuits from one location. Who is correct?

    A. Technician A

    B. Technician B

    C. Both A and B

    D. Neither A nor B

19. Technician A says compressed air molecules reduces the resistance that must be overcome by lower ignition voltage. Technician B says compressed air molecules adds resistance that must be overcome by higher ignition voltage. Who is correct?

    A. Technician A

    B. Technician B

    C. Both A and B

    D. Neither A nor B

20. Technician A says he can check the integrity of the ignition ground circuit by using a DVOM and measuring the voltage between the negative battery terminal and the ignition ground circuit. Technician B says when a voltage drop test is performed on the ignition ground circuit the voltage value should be 0.5 volts or more. Who is correct?

    A. Technician A

    B. Technician B

    C. Both A and B

    D. Neither A nor B

POST TEST

21. A customer brings is car in with a complaint of hard starting. The symptom is verified; cranking time exceeds 5 seconds. Technician A says this could be caused by a weak spark condition. Technician B says a weak spark condition could be caused by low available voltage to the coil's primary circuit. Who is correct?

    A. Technician A

    B. Technician B

    C. Both A and B

    D. Neither A nor B

22. A vehicle with a DI system is towed in for a crank no start concern. A spark tester is used to confirm there is no spark. Technician A says a 12 volt test light can be used to check if the primary sub-system is operating. Technician B says if a 12 volt test light is connected between ground and the negative terminal of the coil, the light should glow brightly as the engine is cranked Who is correct?

    A. Technician A

    B. Technician B

    C. Both A and B

    D. Neither A nor B

23. Technician A says that primary current flow grounds when the PCM sends out an IDM signal. Technician B says the coil produces secondary high voltage when current stops flowing through its primary windings. Who is correct?

    A. Technician A

    B. Technician B

    C. Both A and B

    D. Neither A nor B

24. A customer brings in his vehicle and says the engine misses. The symptom is verified and an engine analyzer is connected to the engine. The firing line is very low on cylinder number 3. Technician A says suspects an open in the plug wire. Technician B suspects a bad ignition coil. Who is correct?

    A. Technician A

    B. Technician B

    C. Both A and B

    D. Neither A nor B

25. Technician A says spark duration is not critical for cruising modes. Technician B says good spark duration is necessary in order to properly ignite leaner air/fuel mixtures. Who is correct?

    A. Technician A

    B. Technician B

    C. Both A and B

    D. Neither A nor B

26. Technician A says the combustion process should be completed by the time the piston reaches TDC on the exhaust stroke. Technician B says spark needs to occur at TDC on the compression stroke. Who is correct?

    A. Technician A

    B. Technician B

    C. Both A and B

    D. Neither A nor B

POST TEST

27. What situation requires the most advanced ignition spark?
    - A. Low speed cruise.
    - B. High speed cruise.
    - C. Deceleration.
    - D. Heavy acceleration.

28. A vehicle with a DI system is brought in because of a spark knock complaint. Technician A say this could be due to improperly adjusted base timing. Technician B says the first check should be ignition timing. Who is correct?
    - A. Technician A
    - B. Technician B
    - C. Both A and B
    - D. Neither A nor B

29. A vehicle with a EI low data rate system has a hard starting concern. The symptom is verified and the diagnosis leads to the function of the DPI circuit. Technician A says the DPI circuit is controlled by the PCM. Technician B says the DPI circuit is used to operate the left coil pack. Who is correct?
    - A. Technician A
    - B. Technician B
    - C. Both A and B
    - D. Neither A nor B

30. A vehicle with a DI system has a no spark condition. Technician A says the DI diagnostic harness can be used to diagnose the system by connecting it to the PCM. Technician B says the DIS tester can be used as an alternative to the DI harness. Who is correct?
    - A. Technician A
    - B. Technician B
    - C. Both A and B
    - D. Neither A nor B

31. Technician A says the TFI intermittent tester can be used to diagnose DI intermittent concerns. Technician B says the symptom must occur when the tester is used in order to identify the problem. Who is correct?
    - A. Technician A
    - B. Technician B
    - C. Both A and B
    - D. Neither A nor B

32. To check the function of the VRS sensor, Technician A says to connect a 12 volt test lamp between ground and the VRS (+) circuit and check to see if the light flashes as the engine is being cranked Technician B says to use a DVOM and measure the AC voltage between the VRS (+) and VRS (-) circuits while the engine is cranking. Who is correct?
    - A. Technician A
    - B. Technician B
    - C. Both A and B
    - D. Neither A nor B

33. A vehicle with a high data rate ignition system is in the shop for a customer complaint of poor performance. A road test reveals that there is a lack of power on acceleration. Technician A says that a problem with the spark timing control system could cause this symptom. Technician B says that an EEC Quick Test should be performed. Who is correct?
    - A. Technician A
    - B. Technician B
    - C. Both A and B
    - D. Neither A nor B

POST TEST

34. A customer brings in a vehicle because the MIL is on. The vehicle is equipped with an EEC V system. Technician A says that an ignition system concern will not cause the MIL to illuminate. Technician B says the misfire monitor can cause the MIL to blink if a type "B/C" misfire is detected. Who is correct?

    A. Technician A

    B. Technician B

    C. Both A and B

    D. Neither A nor B

35. A customer complains of a miss on acceleration. There is an OASIS message that addresses the concern. Technician A says to begin by performing the service specified by the OASIS message. Technician B says not to deviate from the diagnostic process. Who is correct?

    A. Technician A

    B. Technician B

    C. Both A and B

    D. Neither A nor B

36. A vehicle equipped with an EEC V system is in the shop for a stalling concern. The MIL is not ON. Technician A says there will not be any DTCs since the MIL is OFF. Technician B says if the ignition system was responsible for the stalling the MIL would blink. Who is correct?

    A. Technician A

    B. Technician B

    C. Both A and B

    D. Neither A nor B

37. A vehicle is brought in for a rough running complaint. The symptom is verified and an EEC Quick Test indicated a system pass. Technician A says a cylinder balance test might detect a cylinder with a weak spark condition. Technician B says a DTC would have been set if there was a weak spark condition with one or more cylinders. Who is correct?

    A. Technician A

    B. Technician B

    C. Both A and B

    D. Neither A nor B

38. A vehicle equipped with a DI system is brought in for an intermittent buck/jerk during cruise. Technician A says the TFI intermittent tester could help identify the problem. Technician B says an intermittent open on the ignition ground circuit could be the problem. Who is correct?

    A. Technician A

    B. Technician B

    C. Both A and B

    D. Neither A nor B

39. A vehicle with an EI-High Data Rate system is in the shop for a surge. A Continuous self test revealed a DTC related to the PIP signal. Technician A says electrical interference can cause the PIP signal to be erratic. Technician B says if the shields used on the ICM wiring are not grounded the PIP signal could be affected by electrical interference. Who is correct?

    A. Technician a

    B. Technician B

    C. Both A and B

    D. Neither A nor B

POST TEST

40. A 1.6L non-turbo Capri is brought in for a spark knock complaint. Technician A says that spark knock can occur if the timing is too far advanced. Technician B says governor weights and a vacuum advance unit are used to control timing on this vehicle. Who is correct?
    - A. Technician A
    - B. Technician B
    - C. Both A and B
    - D. Neither A nor B

41. Technician A says that the ICM on a Association vehicle is used to limit secondary voltage. Technician B says the SPOUT signal, on a Association vehicle with electronically controlled timing, determines when the coil will fire. Who is correct?
    - A. Technician A
    - B. Technician B
    - C. Both A and B
    - D. Neither A nor B

42. An Association vehicle is in the shop for a no start problem. A no spark condition has been identified. Technician A says the vehicle may have an engine speed and position sensor that operates optically with an LED and a rotating disc. Technician B says a failed optical sensor will not cause a no spark condition. Who is correct?
    - A. Technician A
    - B. Technician B
    - C. Both A and B
    - D. Neither A nor B

43. Technician A says the optical sensor used on an Association ignition system generates a square wave signal with an amplitude between 0 volts and 12 volts. Technician B says the optical sensor generates an AC signal that has an amplitude between 0 volts and 5 volts. Who is correct?
    - A. Technician A
    - B. Technician B
    - C. Both A and B
    - D. Neither A nor B

44. Technician A says there is an Association vehicle that uses a combination of optical and Hall effect sensors to provide engine speed and position information. Technician B says that there is an ignition configuration used on Association vehicles that has a CKP1 sensor and a CKP2 sensor. Who is correct?
    - A. Technician A
    - B. Technician B
    - C. Both A and B
    - D. Neither A nor B

45. Technician A says the ignition coil on an Association vehicle may be located inside the distributor. Technician B says the ICM on an Association vehicle may be located inside the distributor. Who is correct?
    - A. Technician A
    - B. Technician B
    - C. Both A and B
    - D. Neither A nor B

POST TEST

46. An Association vehicle is brought in with a complaint of rough running. The symptom has been verified and no codes were received from a quick test. Technician A says since there are no codes the problem cannot be EEC related. Technician B says a switch monitor test will determine if there is a problem with the secondary ignition subsystem. Who is correct?

    A. Technician A

    B. Technician B

    C. Both A and B

    D. Neither A nor B

47. Technician A says only the Super STAR II can retrieve DTCs from an Association system. Technician B says only the NGS can retrieve DTCs on an Association EEC system. Who is correct?

    A. Technician A

    B. Technician B

    C. Both A and B

    D. Neither A nor B

48. Technician A says that the timing is non-adjustable on an Association vehicle with electronically controlled timing. Technician B says the timing is non-adjustable on an Association vehicle with mechanically controlled timing. Who is correct?

    A. Technician A

    B. Technician B

    C. Both A and B

    D. Neither A nor B

49. Technician A says that the timing is non-adjustable on an Association vehicle with electronically controlled timing. Technician B says the timing is non-adjustable on an Association vehicle with mechanically controlled timing. Who is correct?

    A. Technician A

    B. Technician B

    C. Both A and B

    D. Neither A nor B

50. Technician A says that if one of the governor weights is damaged on a 1.6L Turbo Capri the knock control module can compensate. Technician B says that if a governor weight is damaged mechanical advance will be affected Who is right?

    A. Technician A

    B. Technician B

    C. Both A and B

    D. Neither A nor B

POST TEST

GLOSSARY OF J1930 TERMINOLOGY

New Term	New Acronyms/ Abbreviations	Old Acronyms/ Term
Accelerator Pedal	AP	– Accelerator – Accelerator Pedal (AP)
Air Cleaner	ACL	– Air Cleaner (ACL) – Thermac Air Cleaner
Air Cleaner Element	ACL Element	– Air Cleaner Element (ACL)
Air Cleaner Housing	ACL Housing	– Air Cleaner Housing (ACH)
Air Cleaner Housing Cover	ACL Housing Cover	– Cleaner Housing Cover (ACL Housing Cover)
Air Conditioning	A/C	– Air Conditioning (AC)
Air Conditioning Clutch	A/C Clutch	– Air Conditioning Clutch (ACC)
Air Conditioning Cycling Switch	A/C Cycling Switch	– Air Conditioning Cycling Switch (ACCS)
Air Conditioning Sensor	A/C Sensor	– Air Conditioning Sensor (A/C Sensor)
Air Conditioning System	A/C System	– Air Conditioning System (ACS)
Automatic Transaxle	A/T	– Electronic Automatic Transaxle (EATX)
Automatic Transmission	A/T	– Electronic Automatic Transmission (EATX)
Barometric Pressure	BARO	– Barometric Pressure (BARO)
Barometric Pressure Sensor	BARO Sensor	– Absolute Pressure Sensor (APS) – Barometric Pressure Sensor (BP Sensor)
Battery Positive Voltage	B+	– Battery Positive Voltage (B+)
Camshaft Position	CMP	– Sync Pickup
Camshaft Position Sensor	CMP Sensor	– Camshaft Position Sensor (CPS) – Camshaft Sensor – Cylinder Identification Sensor (Cylinder ID Sensor) (CID)
Canister	Canister	– Canister
Carburetor	CARB	– Feed Back Carburetor (FBC)
Central Fuel Injection System	CFI System	– Continuous Injection System (CIS)
Central Multiport Fuel Injection	Central MFI	– Central Multiport Fuel Injection (CMFI) – Fuel Injection (FI)
Charge Air Cooler	CAC	– After Cooler – Inter Cooler
Closed Loop	CL	– Closed Loop System (CLS)
Closed Throttle Position	CTP	– Closed Throttle Position (CTP)
Closed Throttle Position Switch	CTP Switch	– Closed Throttle Switch
Clutch Pedal Position	CPP	– Clutch Pedal Position (CPP)

GLOSSARY OF J1930 TERMINOLOGY

New Term	New Acronyms/ Abbreviations	Old Acronyms/ Term
Clutch Pedal Position Switch	CPP Switch	– Clutch Engage Switch (CES) – Clutch Start Switch – Clutch Switch
Compact Disc Read Only Memory	CDROM	– Compact Disc Read Only Memory (CDROM)
Continuous Fuel Injection	CFI	– Continuous Injection System (CIS) – Continuous Injection System — Electronic (Continuous Injection System-E) (CIS-E) – Fuel Injection (FI) – K-Jetronic – KE-Jetronic – KE-Motronic
Continuous Fuel Injection System	CFI System	– Continuous Injection System (CIS)
Continuous Trap Oxidizer	CTOX	– Continuous Trap Oxidizer (CTO) – Trap Oxidizer — Continuous (TOC)
Crankshaft Position	CKP	– Crankshaft Position (CP) – Position Indicator Pulse (PIP)
Crankshaft Position Sensor	CKP Sensor	– Crankshaft Position Sensor (CPS) – Crank Angle Sensor
Data Link Connector	DLC	– Assembly Line Communications Link (ALCL) – Assembly Line Diagnostic Link (ALDL) – Self Test Connector – Vehicle In Process Connector (VIP Connector)
Diagnostic Test Mode	DTM	– Modes
Diagnostic Trouble Code	DTC	– Self Test Codes
Differential Pressure Feedback Exhaust Gas Recirculation System	Differential Pressure Feedback EGR System	– Differential Pressure Feedback EGR System
Direct Fuel Injection	DFI	– Direct Injection (DI) – Direct Injection — Diesel (DID) – Fuel Injection (FI)
Distributor Ignition	DI	– Capacitive Discharge Ignition (CDI) – Closed Bowl Distributor – Electronic Ignition (EI) (with Distributor) – Electronic Spark Advance Control (ESAC) – High Energy Ignition (HEI) – Remote Mount Thick Film Ignition (Remote Mount TFI) – Thick Film Ignition (TFI)
Distributor Ignition Capacitor	DI Capacitor	– Condenser

GLOSSARY OF J1930 TERMINOLOGY

New Term	New Acronyms/ Abbreviations	Old Acronyms/ Term
Distributor Ignition Control Module	Distributor ICM	– Electronic Distributor Ignition System Module (EDIS Module)
Distributor Ignition System	DI System	– Electronic Distributor Ignition System (EDIS)
Early Fuel Evaporation	EFE	– Early Fuel Evaporation (EFE)
Electrically Erasable Programmable Read Only Memory	EEPROM	– Electrically Erasable Programmable Read Only Memory (E2PROM)
Electronic Continuous Fuel Injection System	Electronic CFI System	– Continuous Injection System — Electronic (Continuous Injection System-E) (CIS-E)
Electronic Engine Control	Electronic EC	– Electronic Engine Control
Electronic Ignition	EI	– Computer Controlled Coil Ignition (C3I) – Distributorless Ignition (DLI) – Electronic Ignition (EI) (without Distributor) – Integrated Direct Ignition (IDI)
Electronic Ignition System	EI System	– Direct Ignition System (DIS) – Distributorless Ignition System (DIS) – Electronic Distributorless Ignition System (EDIS)
Engine Control	EC	– Electronic Engine Control (EEC)
Engine Control Module	ECM	– Engine Control Module (ECM)
Engine Coolant Level	ECL	– Engine Coolant Level (ECL)
Engine Coolant Level Indicator	ECL Indicator	– Engine Coolant Level Indicator
Engine Coolant Temperature	ECT	– Engine Coolant Temperature (ECT)
Engine Coolant Temperature Sensor	ECT Sensor	– Coolant Temperature Sensor (CTS) – Engine Coolant Temperature Sender (ECT Sender)
Engine Coolant Temperature Switch	ECT Switch	– Coolant Temperature Switch (CTS)
Engine Speed	RPM	– Crankshaft Speed – Revolutions Per Minute (RPM)
Engine Speed Sensor	RPM Sensor	– Crankshaft Speed Sensor
Erasable Programmable Read Only Memory	EPROM	– Erasable Programmable Read Only Memory (EPROM)
Evaporative Emission	EVAP	– Evaporative Emission (EVAP)
Evaporative Emission Canister	EVAP Canister	– Canister – Charcoal Canister
Evaporative Emission Canister Purge	EVAP Canister Purge	– EVAP CANP – Canister Purge (CANP)

New Term	New Acronyms/ Abbreviations	Old Acronyms/ Term
Evaporative Emission Canister Purge Valve	EVAP Canister Purge Valve	– Canister Purge Valve – Evaporative Emission Purge Valve (EVAP Purge Valve) – Canister Purge Vacuum Switching Valve (Canister Purge VSV) – Duty Solenoid for Purge Valve – Vacuum Solenoid Valve (Canister) (VSV) – Vacuum Solenoid Valve (EVAP) (VSV)
Evaporative Emission System	EVAP System	– Evaporation Emission Control System (EECS)
Exhaust Gas Recirculation	EGR	– Digital Exhaust Gas Recirculation (Digital EGR)
Exhaust Gas Recirculation Backpressure Transducer	EGR Backpressure Transducer	– Backpressure Transducer
Exhaust Gas Recirculation Diagnostic Valve	EGR Diagnostic Valve	– EGR Diagnostic Valve
Exhaust Gas Recirculation System	EGR System	– EGR System
Exhaust Gas Recirculation Temperature	EGRT	– EGR Temperature
Exhaust Gas Recirculation Temperature Sensor	EGRT Sensor	– Recirculated Exhaust Gas Temperature Sensor (REGTS)
Exhaust Gas Recirculation Thermal Vacuum Valve	EGR TVV	– EGR Thermal Vacuum Valve (EGR TVV)
Exhaust Gas Recirculation Vacuum Regulator Solenoid	EGR Vacuum Regulator Solenoid	– EGR Vacuum Regulator Solenoid (EVR Solenoid)
Exhaust Gas Recirculation Vacuum Regulator Valve	EGR Vacuum Regulator Valve	– EGR Vacuum Regulator Valve (EVRV)
Exhaust Gas Recirculation Valve	EGR Valve	– EGR Valve (EGRV)
Exhaust Gas Recirculation Valve Control	EGR Valve Control	– EGR Valve Control (EGRVC)
Exhaust Gas Recirculation Valve Position Sensor	EGR Valve Position Sensor	– EGR Valve Position Sensor (EVP Sensor)
Fan Control	FC	– Electro-Drive Fan Control (EDF Control) – Engine Coolant Fan Control – High Electro-Drive Fan Control (HEDF Control) – Radiator Fan Control
Fan Control Module	FC Module	– Fan Control Module
Fan Control Relay	FC Relay	– Fan Motor Control Relay – Radiator Fan Relay
Feedback Pressure Exhaust Gas Recirculation Sensor	Feedback Pressure EGR Sensor	– Pressure Feedback Exhaust Gas Recirculation Sensor (PFE) – Pressure Feedback EGR)

GLOSSARY OF J1930 TERMINOLOGY

New Term	New Acronyms/ Abbreviations	Old Acronyms/ Term
Flash Electrically Erasable Programmable Read Only Memory	FEEPROM	– Flash EEPROM
Flash Erasable Programmable Read Only Memory	FEPROM	– Flash EPROM
Flexible Fuel	FF	– Flexible Fuel (FF)
Flexible Fuel Sensor	FF Sensor	– Alcohol Concentration Sensor – Fuel Concentration Sensor – Fuel Quality Sensor – Percent Alcohol Sensor – Variable Fuel Sensor
Fourth Gear	4GR	– Fourth Gear (4GR)
Fuel Level Sensor	Fuel Level Sensor	– Fuel Sensor
Fuel Pressure	Fuel Pressure	– Fuel Pressure
Fuel Pressure Regulator	Fuel Pressure Regulator	– Fuel Regulator
Fuel Pump	FP	– Fuel Pump (FP)
Fuel Pump Module	FP Module	– Fuel Module – Fuel Sender – Fuel Tank Unit – In Tank Module
Fuel Pump Relay	FP Relay	– Fuel Pump Relay
Fuel Trim	FT	– Adaptive Fuel Strategy
Generator	GEN	– Alternator (ALT)
Governor	Governor	– Governor
Governor Control Module	GCM	– Governor Electronic Module (GEM)
Ground	GND	– Ground (GND)
Heated Oxygen Sensor	HO2S	– Heated Exhaust Gas Oxygen Sensor (HEGO Sensor) – Heated Oxygen Sensor (HOS)
High Speed Fan Control Switch	High Speed FC Switch	– High Speed Fan Control Switch (High Speed FC Switch)
Idle Air Control	IAC	– Idle Air Bypass Control – Idle Speed Control (ISC) – Idle Speed Control Bypass Air (ISC BPA)
Idle Air Control Thermal Valve	IAC Thermal Valve	– Fast Idle Thermo Valve
Idle Air Control Valve	IAC Valve	– Air Valve – Fast Idle Thermo Valve – Idle Air Control Valve (IACV)
Idle Speed Control	ISC	– Idle Speed Control (ISC) – Throttle Opener
Idle Speed Control Actuator	ISC Actuator	– Idle Speed Control Actuator (ISC Actuator)

GLOSSARY OF J1930 TERMINOLOGY

New Term	New Acronyms/ Abbreviations	Old Acronyms/ Term
Idle Speed Control Solenoid Vacuum Valve	ISC Solenoid Vacuum Valve	– Throttle Opener Vacuum Switching Valve (Throttle Opener VSV) – Vacuum Solenoid Valve (Throttle) (VSV)
Ignition Control	IC	– Electronic Spark Advance (ESA) – Electronic Spark Timing (EST)
Ignition Control Module	ICM	– Distributorless Ignition System Module (DIS Module) – Thick Film Ignition Module (TFI Module)
Indirect Fuel Injection	IFI	– Fuel Injection (FI) – Indirect Fuel Injection (IDFI) – Indirect Diesel Injection (IDI)
Inertia Fuel Shutoff	IFS	– Inertia Fuel Shutoff (IFS)
Inertia Fuel Shutoff Switch	IFS Switch	– Inertia Switch
Intake Air	IA	– Air Intake
Intake Air Duct	IA Duct	– Air Intake Duct
Intake Air System	IA System	– Air Intake System
Intake Air Temperature	IAT	– Air Charge Temperature (ACT) – Manifold Air Temperature (MAT) – Throttle Body Temperature (TBT) – Vane Air Temperature (VAT)
Intake Air Temperature Sensor	IAT Sensor	– Air Temperature Sensor (ATS) – Intake Air Temperature Sensor (IATS) – Manifold Air Temperature Sensor (MATS)
Keep Alive Random Access Memory	Keep Alive RAM	– Keep Alive Memory (KAM)
Knock Sensor	KS	– Detonation Sensor (DS)
Long Term Fuel Trim	Long Term FT	– Block Learn Matrix (BLM) – Block Learn Memory (BLM) – Block Learn Multiplier (BLM)
Low Speed Fan Control Switch	Low Speed FC Switch	– Low Speed Fan Control Switch (Low Speed FC Switch)
Malfunction Indicator Lamp	MIL	– Check Engine – Service Engine Soon
Manifold Absolute Pressure	MAP	– Manifold Absolute Pressure (MAP)
Manifold Absolute Pressure Sensor	MAP Sensor	– Intake Manifold Absolute Pressure Sensor – Manifold Absolute Pressure Sensor (MAPS) – Pressure Sensor (P-Sensor)
Manifold Differential Pressure	MDP	– Manifold Differential Pressure (MDP)
Manifold Differential Pressure Sensor	MDP Sensor	– Vacuum Sensor (VAC Sensor)

GLOSSARY OF J1930 TERMINOLOGY

New Term	New Acronyms/ Abbreviations	Old Acronyms/ Term
Manifold Surface Temperature	MST	– Manifold Surface Temperature (MST)
Manifold Vacuum Zone	MVZ	– Manifold Vacuum Zone (MVZ)
Manifold Vacuum Zone Switch	MVZ Switch	– Vacuum Switches
Mass Air Flow	MAF	– Air Flow Control (AFC) – Air Flow Meter
Mass Air Flow Sensor	MAF Sensor	– Air Flow Meter – Air Flow Sensor (AFS) – Hot Wire Anemometer
Mixture Control	MC	– Feed Back Control (FBC) – Mixture Control (M/C)
Mixture Control Solenoid	MC Solenoid	– Mixture Control Solenoid (MCS)
Multiport Fuel Injection	MFI	– D-Jetronic – Digital Fuel Injection (DFI) – Electronic Fuel Injection (EFI) – Fuel Injection (FI) – L-Jetronic – LH-Jetronic – Motronic – Multipoint Injection (MPI) – Multiport Injection (MPI) – Port Fuel Injection (PFI) – Programmed Fuel Injection (PGM-FI) – Tuned Port Injection (TPI)
Non Volatile Random Access Memory	NVRAM	– Keep Alive Memory (KAM) – Non Volatile Memory (NVM)
Oil Pressure Sensor	Oil Pressure Sensor	– Oil Pressure Sender
Oil Pressure Switch	Oil Pressure Switch	– Oil Pressure Switch
On-Board Diagnostic	OBD	– Self Test
Open Loop	OL	– Open Loop (OL)
Oxidation Catalytic Converter	OC	– Continuous Oxidation Catalyst (COC) – Oxidation Catalyst (OC)
Oxygen Sensor	O2S	– Exhaust Gas Oxygen Sensor (EGO Sensor, EGOS) – Exhaust Gas Sensor (EGS) – Exhaust Oxygen Sensor (EOS) – Lambda – Oxygen Sensor (O2 Sensor, OS)
Park/Neutral Position	PNP	– Park/Neutral (P/N)
Park/Neutral Position Switch	PNP Switch	– Neutral Drive Switch (NDS) – Neutral Gear Switch (NGS) – Neutral Position Switch (NPS) – Neutral Safety Switch

New Term	New Acronyms/ Abbreviations	Old Acronyms/ Term
Periodic Trap Oxidizer	PTOX	– Trap Oxidizer — Periodic (TOP)
Positive Crankcase Ventilation	PCV	– Positive Crankcase Ventilation (PCV)
Positive Crankcase Ventilation Valve	PCV Valve	– Positive Crankcase Ventilation Valve (PCV Valve)
Power Steering Pressure	PSP	– Power Steering Pressure (PSP)
Power Steering Pressure Switch	PSP Switch	– Power Steering Pressure Switch (P/S Pressure Switch, PSPS)
Powertrain Control Module	PCM	– Electronic Control Assembly (ECA) – Electronic Control Unit 4 (ECU4) – Electronic Engine Control Processor (EEC Processor) – Microprocessor Control Unit (MCU) – Single Board Engine Control (SBEC) – Single Module Engine Control (SMEC)
Pressure Transducer Exhaust Gas Recirculation System	Pressure Transducer EGR System	– Pressure Transducer EGR System
Programmable Read Only Memory	PROM	– Programmable Read Only Memory (PROM)
Pulsed Secondary Air Injection	PAIR	– Air Injection Reactor (AIR) – Air Injection Valve (AIV) – Pulsair – Thermactor II
Pulsed Secondary Air Injection Valve	PAIR Valve	– Reed Valve
Random Access Memory	RAM	– Random Access Memory (RAM)
Read Only Memory	ROM	– Read Only Memory (ROM)
Relay Module	RM	– Integrated Relay Module
Scan Tool	ST	– Scan Tool
Secondary Air Injection	AIR	– Air Injection (AI) – Air Injection Reactor (AIR) – Thermac – Thermactor
Secondary Air Injection Bypass	AIR Bypass	– Air Management 1 (AM1) – Secondary Air Injection Bypass (AIRB) – Thermactor Air Bypass (TAB)
Secondary Air Injection Bypass Valve	AIR Bypass Valve	– Secondary Air Bypass Valve (SABV)
Secondary Air Injection Control Valve	AIR Control Valve	– Air Control Valve – Secondary Air Check Valve (SACV)
Secondary Air Injection Diverter	AIR Diverter	– Air Management 2 (AM2) – Secondary Air Injection Diverter (AIRD) – Thermactor Air Diverter (TAD)
Secondary Air Injection Pump	AIR Pump	– Air Injection Pump (AIP)

GLOSSARY OF J1930 TERMINOLOGY

New Term	New Acronyms/ Abbreviations	Old Acronyms/ Term
Secondary Air Injection Switching Valve	AIR Switching Valve	– Secondary Air Switching Valve (SASV)
Sequential Multiport Fuel Injection	SFI	– Fuel Injection (FI) – Sequential Electronic Fuel Injection (SEFI) – Sequential Fuel Injection (SFI)
Service Reminder Indicator	SRI	– Check Engine – Engine Maintenance Reminder (EMR) – Oxygen Sensor Indicator (OXS) – Service Engine Soon
Short Term Fuel Trim	Short Term FT	– Integrator (INT)
Smoke Puff Limiter	SPL	– Smoke Puff Limiter (SPL)
Supercharger	SC	– Supercharger (SC)
Supercharger Bypass	SCB	– Supercharger Bypass (SCB)
Supercharger Bypass Solenoid	SCB Solenoid	– Supercharger Bypass Solenoid (SBS)
System Readiness Test	SRT	– System Readiness Test (SRT)
Thermal Vacuum Valve	TVV	– Thermal Vacuum Switch (TVS)
Third Gear	3GR	– Third Gear (3GR)
Three Way Catalytic Converter	TWC	– Three Way Catalytic Converter (TWC)
Three Way + Oxidation Catalytic Converter	TWC + OC	– Dual Bed
Throttle Body	TB	– Fuel Charging Station
Throttle Body Fuel Injection	TBI	– Central Fuel Injection (CFI) – Electronic Fuel Injection (EFI) – Fuel Injection (FI) – Monotronic – Single Point Injection (SPI)
Throttle Position	TP	– Throttle Position (TP)
Throttle Position Sensor	TP Sensor	– Throttle Position Sensor (TPS) – Throttle Potentiometer
Throttle Position Switch	TP Switch	– Throttle Position Switch (TPS)
Torque Converter Clutch	TCC	– Converter Clutch Control (CCC) – Converter Clutch Override (CCO) – Viscous Converter Clutch (VCC)
Torque Converter Clutch Relay	TCC Relay	– Lock Up Relay
Torque Converter Clutch Solenoid Valve	TCC Solenoid Valve	– Lock Up Solenoid Valve (LUS)
Transmission Control Module	TCM	– Transmission Control Module
Transmission Range	TR	– Park, Reverse, Neutral, Drive, Low (PRNDL) – Selection Lever Position (SLP) – Transmission Range Selection (TRS)

GLOSSARY OF J1930 TERMINOLOGY

New Term	New Acronyms/ Abbreviations	Old Acronyms/ Term
Transmission Range Sensor	TR Sensor	– Manual Lever Position Sensor (MLP Sensor)
Transmission Range Switch	TR Switch	– Manual Range Position Switch (MRPS) – Transmission Position Switch – Transmission Range Selector Switch (TRSS)
Turbocharger	TC	– Turbo
Vehicle Speed Sensor	VSS	– Distance Sensor – Pulse Generator (PG)
Voltage Regulator	VR	– Voltage Regulator (VR)
Volume Air Flow	VAF	– Air Flow Control (AFC) – Air Flow Meter – Vane Air Flow
Volume Air Flow Sensor	VAF Sensor	– Air Flow Meter – Air Flow Sensor (AFS)
Warm Up Oxidation Catalytic Converter	WU-OC	– Light Off Catalyst
Warm Up Three Way Catalytic Converter	WU-TWC	– Light Off Catalyst
Wide Open Throttle	WOT	– Full Throttle
Wide Open Throttle Switch	WOT Switch	– Wide Open Throttle Switch (WOTS)

GLOSSARY

A/C: Air Conditioning.

AC: Alternating Current.

ASE: National Institute for Automotive Service Excellence.

ATDC: After Top Dead Center.

Acceleration: A change to a faster speed or from stopped to moving. Acceleration is the mode of engine operation in which full power or nearly full power is required and produced for any given RPM.

After Top Dead Center (ATDC): Position of the crankshaft connecting rod journal after it has passed the highest point of the piston stroke. Crankshaft position is measured in degrees of crankshaft rotation before or after top dead center.

Air/Fuel Ratio: The number of pounds of air in proportion to the number of pounds of fuel in a mixture.

Air Conditioning (A/C): A system to remove heat and moisture from the air.

Alternating Current (AC): An electric current that reverses its direction at regularly occurring intervals (frequency).

Analog: A continuously variable voltage signal.

Application: Usage for a specific purpose.

Association Vehicles: Vehicles sold by Ford Motor Company in North America that were designed and/or manufactured by foreign-based automobile manufacturers in a partnership association with Ford.

B+: Battery positive voltage.

BOB: Breakout Box.

BOO: Brake On-Off.

BTDC: Before Top Dead Center.

Backfire: Combustion occurring outside of the cylinder, either in the intake manifold or the exhaust system.

Base Engine Timing: Spark advance in degrees before top dead center that provides the best combustion and power at very low RPM for starting.

Base Timing: Spark advance in degrees before top dead center without any control from the PCM or ICM.

Battery: An electrical storage device designed to produce a DC voltage by means of an electrochemical reaction.

Battery Positive Voltage (B+): The positive voltage from the battery or any circuit connected directly to the battery.

Before Top Dead Center (BTDC): Position of the crankshaft connecting rod journal prior to reaching the highest point of the piston stroke. Crankshaft position is measured in degrees of crankshaft rotation before or after top dead center.

Brake On-Off (BOO) switch: A switch sensor circuit to the PCM to detect whether or not the brakes are applied.

Breakout Box: A service tool which connects in series (tees into) between a module (such as PCM) and its harness connector. A breakout box permits measurement of input and output electrical signals by probing terminals which correspond to the circuits in the harness connector. A separate meter(s) must be used to probe the terminals.

CCD: Computer Controlled Dwell.

CFR: Customer Flight Recorder

CID: Cylinder Identification.

CKP: Crankshaft Position.

CMP: Camshaft Position.

Camshaft: A shaft on which lobes are positioned to open and close the intake and exhaust valves at the appropriate time. The camshaft turns at one-half crankshaft RPM.

Camshaft Position (CMP): Indicates the place in the camshaft's rotation that determines which cylinder is on its compression stroke.

Carbon: A non-metallic compound found in all motor fuels which may accumulate in the form of soot when it is not completely burned.

Cause: Anything producing a result or effect.

Centrifugal Advance Mechanism: A device operated by the movement of flyweights in a distributor which advances ignition timing as RPM increases.

Centrifugal Force: A force acting outward from the center of a rotating object.

Circuit: A path for the flow of electricity between any two points.

Closed Circuit: A circuit that is complete from the power source to the load and back to the ground side of the power source. The current flow is equal throughout the circuit, so the conductors must have sufficient capacity at any point in the circuit.

Coil: Shortened term for Field Coil or Ignition Coil.

Coil - : Coil negative (ground) terminal

Coil +: Coil positive (battery terminal

Coil Pack: An assembly of more than one coil in a single module.

Coil Saturation: The condition in which the coil windings are fully energized, and the magnetic field surrounding the coil windings has reached its maximum intensity.

Coil Cable or Wire: The wire that carries high voltage current from the coil to the distributor cap in a distributor type ignition system.

Collapse: Occurs to the magnetic field when the current through the coil windings is turned off. The waves of magnetic force move quickly to the center conductor (core) of the coil.

Computed Timing: The timing of the ignition spark determined by the PCM. Computed timing is the total number of degrees BTDC. This includes base timing plus or minus additional degrees determined from inputs from various sensors.

Combustion: The burning of an air and fuel mixture.

Combustion Chamber: The area above the top of the piston at TDC in which the air/fuel mixture is compressed prior to ignition.

Component: A part or assembly within a system.

Compression Pressure: The pressure in the cylinder with the piston at the top of its compression stroke, without additional pressure added from combustion.

Compression Stroke: The second stroke in the four-stroke cycle in which the upward movement of the piston squeezes the air and fuel mixture into the combustion chamber.

Computer: An electronic machine which uses stored instructions and information to obtain decisions rapidly.

Computer Controlled Dwell (CCD): A system which regulates the length of time that the ignition coil's primary winding is energized to achieve coil saturation and prevent coil overheating. The leading edge of the SPOUT signal determines when the coil primary current turns ON, and the trailing edge determines when the coil primary current turns OFF.

Concern: A worry or anxiety.

Condition: A state of being.

Conductor: A material, normally metallic, that permits easy passage of heat or electricity.

Continuity: A condition where a circuit is complete (closed or continuous) between given points.

Continuous Codes: Diagnostic Trouble Codes stored in Keep Alive Memory (KAM) as a result of a failure, either intermittent or constant, detected in one of the sensor circuits. These codes are issued as a result of information stored during Continuous Self-Test, while the vehicle was in operation.

Continuous Memory: A portion of Keep Alive Memory (KAM) used to store Diagnostic Trouble Codes (DTC's) generated during Continuous Self Test.

Continuous Self Test: A test of the EEC system conducted by the PCM at all times when the vehicle is running.

Control: A means or device to direct a mechanism and regulate a process.

Cranking: Turning the crankshaft with an electric starter.

Crankshaft: The part of an engine that converts the reciprocating motion of the pistons into rotary motion.

Crankshaft Position: Indicates the place in the crankshaft's rotation that determines how far the piston has traveled on its compression stroke. Crankshaft position also determines speed (RPM).

Cruise: The mode of engine operation in which the throttle is partially open, and the load is moderate. During cruise, less than full power is required and produced.

Current: A flow of electrical charge, measured in amperes. Generally, in automotive applications, current flow is from battery positive to battery negative.

Curriculum: All of the courses in a particular subject.

Customer Flight Recorder (CFR): A diagnostic tool that will record vehicle operation data over a period of time, used for intermittent malfunctions.

GLOSSARY

Cylinder: The chamber in which the piston moves in an engine.

Cylinder Balance Test: A diagnostic procedure to determine the relative amount of power contributed by each cylinder with the engine running.

Cylinder Identification (CID): Determination of which cylinder in sequence requires fuel and/or ignition based upon crankshaft and camshaft position information.

DC: Direct Current.

DI: Distributor Ignition.

DIS: Distributorless Ignition System

DLC: Data Link Connector

DP: Dual Plug.

DPI: Dual Plug Inhibit.

DTC: Diagnostic Trouble Code.

DTM: Diagnostic Test Mode.

DVOM: Digital Volt-Ohm Meter.

Data Link Connector (DLC): The terminal on the vehicle where a scan tool is connected to obtain information from the PCM. Detonation: The sudden explosion of an air/fuel mixture, rather than normal combustion which consists of a flame front traveling evenly through the air/fuel mixture. Detonation causes spark knock.

Diagnosis: The process of deciding the cause of an abnormal condition by examining the symptoms.

Diagnostic Test Mode (DTM): A capability of the On-Board Diagnostic (OBD) System. This may include different functional states to observe signals, a base level to read Diagnostic Trouble Codes (DTCs), a monitor level which includes information on signal levels, bi-directional control with testers, and the ability to interface with remote diagnosis testers.

Diagnostic Trouble Code (DTC): An alpha-numeric identifier for a fault condition. DTCs are identified by the On-Board Diagnostic (OBD) System in the PCM.

Diaphragm: A flexible partition that separates one chamber from another. The diaphragm is used to move a rod or operate a valve when there is a difference in pressures between the two chambers.

Digital: A signal that has two states: ON or OFF.

Digital Volt-Ohm Meter (DVOM): A meter used to measure voltage and resistance with a numerical read-out.

Diode: An electrical device that permits current to flow in only one direction.

Direct Current (DC): An electric current that flows in only one direction and stays constant in value.

Distributor: The assembly that contains the camshaft position sensor (CMP) and a switching device to direct the current from the coil wire to the appropriate spark plug wire. The switching device consists of the distributor cap and distributor rotor. A shaft driven by the camshaft turns the rotor and the armature of the CMP.

Distributor Cap: The device that contains the terminals for transmitting current from the ignition coil to the ignition cables (spark plug wires). There is one terminal for each spark plug.

Distributor Ignition (DI): A system in which the voltage from the coil's secondary windings is mechanically switched in proper sequence to the proper spark plugs. The switch consists of the rotor and distributor cap.

Distributor Rotor: The device that directs the current from the ignition coil to the individual terminals around the distributor cap.

Distributorless Ignition System (DIS): Obsolete term, now called Electronic Ignition (EI) system. Also, DIS is the name that Ford previously used for its EI-Low Data Rate ignition system.

Driveability: The ability of the vehicle's powertrain to perform to the driver's expectations. This includes eager response and progressive application of power, freedom from stalling, easy starting, and lack of disturbing noises or vibrations.

Dual Hall Sensor: A device which contains a Hall Effect device to determine Cylinder Identification (CID) and another Hall Effect device to determine Crankshaft Position (CKP) and speed.

Dual Plug (DP): An ignition system which uses two spark plugs per cylinder to achieve better combustion.

Dual Plug Inhibit (DPI): Feature of a dual plug ignition system which allows the ignition system to operate either one plug or both plugs per cylinder.

Dwell: The length of time that current flows through the primary circuit of an ignition coil for each spark generation.

EDIS: Electronic Distributorless Ignition System.

EEC: Electronic Engine Control.

EEC IV: Ford's fourth generation of electronic engine controls for NAAO vehicles.

EEC V: Ford's fifth generation of electronic engine controls for NAAO vehicles. The primary difference from the previous generation is that EEC V features OBD-II.

EI: Electronic Ignition.

EMF: Electromotive Force.

EVTM: Electrical/Vacuum Troubleshooting Manual.

Electrical/Vacuum Troubleshooting Manual (EVTM): A book which contains wiring and vacuum hose schematics.

Electrical System: The system of wiring, switches, relays, and modules associated with distributing electricity.

Electricity: The movement of electrons through a conductor from an area of high electron concentration to one of low electron concentration. Electricity is a fundamental force found in nature.

Electrode: Posts or plates which have an electrical potential relative to each other. Electrodes are either positive or negative.

Electron: A negatively charged particle that forms part of an atom. Electrons in motion produce electric current.

Electronic Distributorless Ignition System (EDIS): Obsolete term, now called Electronic Ignition (EI) system. Also, EDIS is the name that Ford previously used for its EI-High Data Rate ignition system.

Electronic Engine Control (EEC): A computer controlled system that controls the fuel, ignition and emission control systems. The purpose of EEC is to provide the appropriate air/fuel ratio, spark timing, idle speed and operation of emission control devices.

Electronic Ignition (EI): A system containing multiple coils in which the voltage from each coil's secondary windings is dedicated to certain spark plugs. The PCM and/or ICM selects the coil to be energized and discharged, based upon inputs for crankshaft and camshaft position.

Emission: Release or discharge of air pollutants from a vehicle. Emission generally refers to exhaust gases (HC, CO, and NOx) and evaporation of liquid fuel (HC).

Emission Controls: The systems which control the amount of vehicle-generated pollutants released into the atmosphere.

Energized: Having the electrical current flowing.

Energy: Capacity for doing work and overcoming resistance.

Engine: A machine designed to convert thermal energy from combustion into mechanical energy to produce force or motion.

Engine speed (RPM): Rotational speed of the engine crankshaft.

Exhaust Emission: Pollutants from the combustion processes that escape into the atmosphere. Carbon monoxide, hydrocarbon and nitrogen oxide are the most hazardous gases in vehicle exhaust.

Expansion: The increase in volume caused by heat generated from the combustion process.

Firing Order: The sequence in which the pistons are on their compression strokes. Example for a four-cylinder engine: 1 3 4 2.

Flux: Electric or magnetic lines of force in motion that create a magnetic field. The location and strength of the lines of force determine the shape and size of the magnetic field.

Flyweights: Weights mounted on a shaft which pivot outward from centrifugal force as the speed of the shaft increases, causing an adjustment to occur in a device or valve.

Frequency: The number of times a voltage signal is repeated per second. Frequency is measured in Hertz.

GND: Ground.

Ground (GND): The return side of a circuit. A ground ultimately connects to the negative terminal of the battery. The path to ground may be through a wire or any metal which conducts electricity, such as the engine and vehicle body.

Hall Effect: A process where current is passed through a semi-conductor at the same time that a magnetic field to produces a small voltage in the semi-conductor.

Hard Fault: A malfunction currently present in the system.

GLOSSARY

Hydrocarbon: A compound containing hydrogen and carbon which is used for fuel in an engine. Unburned hydrocarbon released to the atmosphere is a pollutant. Unburned hydrocarbon comes from evaporation of liquid fuel (evaporative emission) or fuel that was not completely burned during combustion (exhaust emission).

IAC: Idle Air Control.

ICM: Ignition Control Module.

ICM PWR: Ignition Control Module Power.

IDL: Idle.

IDM: Ignition Diagnostic Monitor.

IGN: Ignition.

IGN GND: Ignition Ground.

Idle: An engine operating mode during which only enough power is required and produced to keep the engine running and to carry loads applied by the transmission and accessories. Idle is a very low engine speed.

Idle Air Control (IAC): A device which regulates the amount of air flowing into the intake manifold during closed throttle conditions.

Idle (IDL) Switch: A switch sensor circuit to the PCM to detect whether or not the throttle is closed.

Ignition (IGN): System to provide high voltage spark for internal combustion engines.

Ignition Cable or Wire: See Spark Plug Wire.

Ignition Coil: A transformer.

Ignition Control Module (ICM): An electronic device that opens and closes the ignition coil's ground circuit.

Ignition Control Module Power (ICM PWR): The circuit which provides battery positive current to the ICM.

Ignition Diagnostic Monitor (IDM): An electrical signal based upon the secondary voltage from each coil discharge. IDM is used to detect ignition faults and drive the vehicle tachometer.

Ignition Ground (IGN GND): The point where the ground path for the ignition coil's primary circuit is attached to the body.

Ignition Switch: The switch that controls the flow of current to the ignition system and electrical system.

Ignition Timing: Relationship between spark plug firing and piston position. Ignition timing is expressed in crankshaft degrees before or after top dead center of the compression stroke for the cylinder.

Induction: The creation of an electric current in a conductor as the conductor passes through a magnetic field, or as a magnetic field passes across a conductor; the air intake path in the engine.

Insulator: A non-conducting substance surrounding a conductor. An insulator is used to prevent a conductor from coming in contact with another conductor, or to prevent leakage of high voltage electricity; a material to reduce conduction of vibration.

Intake Valve: The valve that opens to allow fresh air/fuel mixture to be drawn or forced into a cylinder.

Intermittent Fault: A malfunction which may not be present or identifiable at the present time.

KAM: Keep Alive Memory.

KAPWR: Keep Alive Power.

KOEO: Key On, Engine Off.

KOER: Key On, Engine Running.

KV: Kilovolts

Keep Alive Memory (KAM): A portion of the memory within the PCM that stores information about faults and retains the information after the vehicle is shut off.

Keep Alive Power (KAPWR): A dedicated, unswitched battery power circuit that maintains KAM.

Key On, Engine Off (KOEO) Self Test: A test of the EEC system conducted by the PCM with power applied and the engine at rest.

Key On, Engine Running (KOER) Self Test: A test of the EEC system conducted by the PCM with the engine operating.

Kilovolt (KV): 1,000 volts.

Knock: A sharp metallic sound produced either by detonation (see Spark Knock) or excessive clearance between reciprocating parts.

Knock Sensor (KS): Detects spark knock within a certain frequency and intensity range, and produces an electrical signal to the PCM.

L: Liter(s).

LED: Light Emitting Diode.

Lean Air/Fuel Mixture: A condition in which the ratio of air to fuel contains more oxygen than is needed to completely burn the quantity of fuel.

Light Emitting Diode (LED): A semi-conductor that gives off light.

Liter: A metric measurement for volume of a space. One liter equals 1,000 cubic centimeters, or about 61 cubic inches.

Load: The amount of work performed by an engine.

MAF: Mass Air Flow.

MAP: Manifold Absolute Pressure.

MIL: Malfunction Indicator Lamp.

MS: Millisecond.

Magnet: Any metal that has the property of attracting iron or steel. This property may be naturally present or artificially induced (electromagnetism).

Magnetic Field: Magnetic lines of force which can be detected at every point in an area.

Magnetic Force: The attracting or repelling forces created by magnets or electric currents, also called flux or magnetic flux.

Magnetism: The properties associated with the field of force produced by a magnet or electric current.

Magnetic Pickup: See Variable Reluctance Device.

Malfunction: Failure to operate properly due to wear, breakage, a disconnect, improper mounting, sticking, leakage, damage, etc.

Malfunction Indicator Lamp (MIL): An on-board warning light to alert the driver of a fault that may affect exhaust emissions. The light will read either Check Engine or Service Engine Soon.

Manifold Absolute Pressure (MAP): The pressure in the intake manifold as compared to a perfect vacuum.

Manifold Vacuum: The vacuum in the intake manifold.

Mass Air Flow: The amount of air in pounds per minute entering the engine intake.

Millisecond (MS): 1/1000 or 0.001 of a second.

Miss: Abbreviation for misfire.

Misfire: Failure to produce power from a cylinder due to a condition caused by ignition, air/fuel mixture or compression pressure inadequacies.

Misfire Monitor: A feature of the EEC V system which detects low cylinder contribution.

Module: A self-contained group of electrical/electronic components which is designed as a single replaceable unit.

Monitor Box: A service tool which connects in series (tees into) between a module (such as the PCM) and its harness connector. The monitor box permits measurement of electrical signals. Meters are integral to the tool.

NAAO: North American Automotive Operations.

NGS: New Generation STAR.

NOx: Nitrogen Oxide.

Naturally Aspirated Engine: An engine which utilizes only the vacuum created by the movement of the pistons to draw in the air/fuel mixture.

New Generation STAR (NGS): A diagnostic tool to read data from the PCM.

Nitrogen Oxide (NOx): An exhaust gas from an internal combustion engine; a principle component of smog.

Non-Turbo: A naturally aspirated engine configuration.

North American Automotive Operations: A division of Ford Motor Company responsible for the design and manufacture of vehicles in the United States, Canada and Mexico.

OASIS: On-line Automotive Service Information System.

OBD: On-Board Diagnostic.

OSR: On-board System Readiness.

OTM: Output Test Mode.

Ohm: A unit of electrical resistance measuring the opposition to current flow.

Ohmmeter: An instrument that measures resistance to current flow. Readings are in ohms.

GLOSSARY

On-Board Diagnostic (OBD): A feature of the PCM to test itself and to test sensors and actuators, store information regarding malfunctions and report the stored information.

On-Board System Readiness (OSR) Test: A function of the PCM in an EEC-V system that checks the status of the various monitors.

Open Circuit: An electrical circuit which does not provide a complete path for the flow of current (no continuity). No current can flow through an open circuit.

Optical Device: A device which uses light and a light sensor.

Oscilloscope: A device that displays an electrical wave on a fluorescent screen.

Output Test Mode (OTM): A testing function that allows outputs to be turned on and off to check the operation of actuators.

Overlay Card: A plastic card used with a monitor box to identify EEC signals for each engine model. The card also programs the monitor box for automatic mode measurements.

PCED: Powertrain Control/Emissions Diagnosis manual.

PCM: Powertrain Control Module.

PID: Parameter Identification.

PIP: Position Indicator Pulse.

PPT: Pinpoint Test.

PVA: Portable Vehicle Analyzer.

Paired Cylinders: An ignition secondary circuit in which the coil provides voltage to the spark plug wires on two cylinders at the same time. One of the cylinders is on its compression stroke and the other is on its exhaust stroke. The circuit is completed to ground by the electrons jumping the air gaps of both spark plugs.

Parameter Identification (PID): A function that allows access to certain data values in an EEC-V system.

Phototransistor: A light-sensitive, solid-state semiconductor.

Piezoelectric: The property exhibited by certain crystals of generating voltage when subjected to pressure.

Pinging: Light intensity spark knock.

Pinpoint Test: Step-by-step instructions to isolate specific concerns.

Portable Vehicle Analyzer (PVA): A diagnostic tool which allows monitoring vehicle operation data while the vehicle is being driven.

Position Indicator Pulse (PIP): The signal to determine crankshaft or camshaft position and speed for ignition and/or fuel injection synchronization.

Power: The amount of force or energy available to do work.

Power Balance: The power provided by a cylinder relative to the power provided by each of the other cylinders in the engine.

Power Stroke: See Combustion Stroke.

Powertrain: The engine and transmission/transaxle assemble.

Powertrain Control Module (PCM): The module that controls the EEC system. It contains a computer, which receives data from sensors and other sources. Based on data received and strategies programmed into the computer's memory, the computer generates output signals to control various engine functions (and transmission function in some vehicles).

Powertrain Control/Emissions Diagnosis (PCED) manual: A book which contains testing procedures, specifications and diagnostic flowcharts.

Pre-ignition: The condition when the air/fuel mixture begins to burn in the combustion chamber prior to occurrence of the ignition spark. Pre-ignition causes detonation.

Pressure: Force exerted against an opposing body; thrust distributed over a surface, expressed in units of force per unit of area.

Primary Circuit: A low voltage circuit or part of a circuit; the input circuit (first stage) of a transformer.

Program: A logical sequence of operations to be performed by a computer in solving a problem or processing data.

QSB: Quarterly Service Bulletin.

Quarterly Service Bulletin (QSB): Technical information updates issued four times per year.

Quick Test: A functional diagnostic test of the EEC system consisting of KOEO, KOER and continuous Self Tests along with vehicle preparation and hookup. Results are displayed as a series of alphanumeric codes.

Quit: To stop the running of an engine unintentionally because of a malfunction.

RPM: Revolutions Per Minute.

RTN: Return.

Ratio: A numerical relationship; the proportional size of two quantities expressed as a quotient of one divided by the other. (Example: 8 to 1 can be expressed as 8/1 or 8:1.)

Reduction Oxidation Catalytic Converter (REDOX): A catalytic converter system designed to reduce NOx emissions at high temperatures, as well as reduce HC and CO emissions at high and low temperatures.

Reference Voltage (VREF): A dedicated circuit that provides a 5.0 volt signal used by some sensors.

Reluctance: The resistance of a material to the flow of magnetic lines of force.

Reluctor: A magnetic material in motion which induces voltage in a nearby coil.

Resistance: The opposition offered by a conductor to the flow of electrical current, measured in ohms. Resistance is different in different materials. Resistance varies with temperature.

Resistor: A device which opposes the flow of electrical current in a circuit.

Revolutions Per Minute (RPM): The number of turns or spins of a shaft in a specific period of time. This is the measurement of the speed of a rotating shaft. (Generally, RPM refers to the speed of the engine crankshaft. However, the speed of any other shaft in a vehicle is also measured in RPM, and most other shafts rotate at a speed that is different than engine RPM.)

Rich Air/Fuel Mixture: A condition in which the ratio of air to fuel contains less oxygen than is needed to completely burn the quantity of fuel.

SBDS: Service Bay Diagnostic System.

SFI: Sequential Fuel Injection.

SIG RTN: Signal Return.

SPOUT: Spark Output.

ST: Scan Tool.

STAR: Self Test Automatic Read-out. (See Super STAR Tester.)

STI: Self Test Input

Scan Tool (ST): A device that communicates with a computer through an electrical connection.

Secondary Cables or Wires: The wires that carry high voltage current in an ignition system, such as the coil secondary wire and the spark plug wires.

Secondary Circuit: A high voltage circuit or part of a circuit; the output circuit (second stage) of a transformer.

Self Test: A part of the functional Quick Test diagnostic procedure which verifies that sensors, actuators and the PCM are connected and operating properly. The inputs and control functions are tested under controlled operating conditions. The actuators are exercised and checked for corresponding results.

Self Test Input (STI): A circuit to the PCM to initiate read-out of Diagnostic Trouble Codes (DTCs).

Semiconductor: A general term for transistors, integrated circuits and other electronic devices made of materials, such as silicon, which are poor electrical conductors.

Sensor: A device that measures an operating condition and provides an input signal to the PCM. The device senses either the absolute value or change in a physical quantity such as temperature, pressure or flow rate, and converts that measurement into an electrical quantity signal.

Sequential Fuel Injection (SFI): A system to spray fuel into the intake manifold runner of each cylinder timed to the position of the pistons.

Service Bay Diagnostic System (SBDS): An engine analyzer system specifically for Ford vehicles.

Short Circuit: Defect in an electric circuit in which electricity flows from one conductor to another, rather than through the intended circuit.

Signal: A voltage condition that transmits specific information in an electronic system.

Signal Return (SIG RTN): A sensor ground circuit.

GLOSSARY

Solid State: Refers to circuits that use transistors, integrated circuits and/or other semiconductors, and does not use any vacuum tubes.

Spark Knock: The sharp metallic sound produced by detonation. Spark knock is distinguished from mechanical sounds by frequency and occurrence only during cruise or acceleration. The volume and intensity may vary from light (pinging) to severe (knocking).

Spark Output (SPOUT): Spark timing information sent from the PCM to the ICM.

Spark Plug: A device that provides an air gap for electrons to jump across, causing intense heat.

Spark Plug Cables or Wires: The wires that carry high voltage current to the spark plugs from the coil or distributor cap.

Speed: The magnitude of velocity in a linear or rotary motion, regardless of direction.

Square Wave: A digital ON/OFF type signal that has a very fast rise and fall time.

Stall: To stop the running of an engine unintentionally because the load is greater than the amount of power produced by the engine.

Starter: The electric motor that turns the engine flywheel to the turn the engine crankshaft. This provides the strokes necessary to cause the engine to begin running on its own power.

Starting: The engine operating mode in which the engine is being cranked for a number of revolutions until the conditions for good combustion are present and the engine begins to run on its own power.

Starting System: The electrical system that operates the starter.

Strategy: A plan for action.

Super STAR II Tester: A tool that reads electrical pulses from the PCM and translates them into digital read-outs corresponding to Diagnostic Trouble Codes.

Switch: A device for making, breaking, or changing the connections in an electrical circuit.

Switch Monitor Test: A function of the PCM which checks input signals from individual switches.

Symptom: An indication of a malfunction.

System: A group of interacting mechanical or electrical components serving a common purpose.

System Pass: A Diagnostic Trouble Code (DTC) which indicates that there are no malfunctions of the type that the EEC system can detect and store. Example: 55 is the DTC for System Pass with NECS.

TACH: Tachometer.

TDC: Top Dead Center.

TFI: Thick Film Integrated.

TP: Throttle Position.

TSB: Technical Service Bulletin.

Tachometer (TACH): A device for measuring RPM.

Technical Service Bulletin (TSB): A notification of a revision to procedures or components, or an alert to a special situation.

Test: A procedure whereby the performance or a component or system is measured under certain conditions.

Thick Film Integrated (TFI): A type of solid state circuit used for the ICM on some Ford products. Throttle: A valve for regulating the flow of intake air to an engine.

Throttle Position (TP): Indicates the position of the throttle plate to measure the driver's demand for power.

Timing: See Ignition Timing and Valve Timing.

Top Dead Center (TDC): Position of the crankshaft connecting rod journal at the highest point of the piston stroke; also called zero (O) degrees BTDC or zero (0) degrees ATDC.

Torque: Twisting or rotational force.

Transformer: A device which contains two sets of coil windings around conductors. When the magnetic field collapses in the primary winding (low voltage), a high voltage is induced in the secondary winding. The total amount of power present remains about the same from primary to secondary, but the voltage to amperage ratio changes. A step-up transformer increases the voltage and decreases the current. An ignition coil is a step-up transformer.

Transistor: A small solid-state switching device which uses semiconductors.

Trigger Wheel: A slang term for the armature used in a magnetic pickup (VRS), Hall effect or optical sensing device.

Turbo: Abbreviated term for Turbocharged or Turbocharger.

Turbocharged Engine: An engine with a centrifugal pump driven by exhaust pressure; used to pressurize intake air, thereby increasing its density and increasing engine power. Pump volume is directly related to exhaust pressure.

V: Volts.

VAF: Volume Air Flow.

VOM: Volt-Ohmmeter.

VREF: Reference Voltage.

VSS: Vehicle Speed Sensor.

Vacuum Advance Mechanism: A mechanical device used to retard timing when engine load is high.

Variable: Changeable.

Variable Reluctance Sensor (VRS): An electrical device which generates current when the magnetic reluctor moves in relation to the location of the coil. The amount of current varies as the reluctor moves toward and then away from the coil.

Vehicle Speed Sensor (VSS): A sensor which provides vehicle speed information.

Velocity: Speed.

Vibration: A high frequency shaking or trembling that can be felt.

Volt: A unit of measurement for the force (pressure) which causes current flow in a circuit.

Voltage: The force (pressure) which causes electrical current flow in a circuit, measured in volts; also known as electromotive force (EMF) or electrical potential.

Voltage Drop: The difference in voltage between any two points in a circuit.

Voltmeter: An instrument that measures voltage. Readings are in volts.

Volt-Ohmmeter (VOM): An analog meter used to measure voltage and resistance by sweep hand movement and a printed scale.

Volume: The amount of space occupied in three dimensions; cubic contents.

Volume Air Flow: The amount of air in cubic feet per minute entering the engine intake.

WOT: Wide Open Throttle.

Waveform: The appearance on an oscilloscope of the variations, over a of period time, in the amplitude of voltage.

Wide Open Throttle (WOT): A condition of maximum air flow through the throttle valve.

Wiggle Test: A test function which records and stores a diagnostic trouble code while the technician is moving and flexing wires and connectors, and tapping components that may be the cause of a malfunction.

Wiring Harness: A bundle of insulated electrical wires covered by an additional insulating jacked. The individual wires emerge from the harness at different take-out (T/O) points to go to various connections.

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